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DEVOTED TO THE USEFUL APPLICATIONS OF COMPRESSED AIR

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COMPRESSED AIR MAGAZINE

EVERYTHING PNEUMATIC.

Vol. XX NOVEMBER, 1915 No. 11

THE MINING ENGINEER

BY W. L. SAUNDERS.*

This is a great day for the Institute of Mining Engineers. We are glad to be here. We are glad that we are alive; happy in the thrill of vitality which is quickened by California spirit and by the elixir of your glorious climate. On behalf of the Institute which I represent, I thank you for giving us this day. In thus honoring the Institute you are paying a tribute of regard and appreciation to the whole mining industry; to the lusty pioneer who blazed the trail and whose dry bones were the only monuments to mark the milestones of his progress; to the educated engineer and the capitalist whose skill and money were spent beneath the soil in daring efforts to release the hidden forces of Nature and put them to the service of mankind. You are paying tribute to the geologist, the chemist, and the metallurgist, for they, too, are mining engineers and members of this Institute.

I speak of California as a mining state; as such were you born. You received your baptism in the waters of the South fork of the American river when Marshall discovered gold at Sutter's mill in 1848. This was the beginning of the Golden Age for California and the world. The Golden Age means more than the age of gold; it is the age of progress, of prosperity and industrial renown and wealth; the age of railways and steamships, of the manufacture of steam-engines, of electricity, of the telephone, the telegraph, the automobile, the aeroplane, the submarine. All these were made possible—yes, they were initiated and installed—through means which were provided by the mining industry. The mining engineer has multiplied and replenished the earth through subduing it; he has released those forces of nature which have been hidden through countless ages; he has through the science of metallurgy and chemistry made it economically possible to widen and enlarge to enormous proportions the use and influence of these forces. Look into the modern locomotive and steamship and we shall see that almost every pound of their vital structure is a product of the mines. The lathe that fashioned the shaft is itself a product of the mine, and it gets its power to turn from coal mined by machines which are themselves products of the mines. You may say to all this that the art of mining is as old as the hills. Let me remind you that mining at low cost, mining low-grade ore, and doing these things on a large scale, and the art of reduction and treatment through metallurgy, are the accomplishments of the mining engineer of our time. This was the key which unlocked those forces which have been the impulse behind the great industrial progress of the world. This, too, has all been accomplished since the discovery of gold in California.

Let us review some of the facts of history. The first half of the nineteenth century was a period marked by little progress in industrial wealth. The world's output of gold from 1800 to 1835 varied from ten to fifteen millions of dollars annually. The yearly product of iron during this period was only between two and three million tons, coal less than fifty million tons, copper less than fifty mil

*Address of the President of the American Institute of Mining Engineers, on Institute Day, Panama-Pacific Exposition.

lion pounds. There were no transcontinental railways, no great steamships, no battleships, no factory system of manufacture, no large corporations. The total gold product of the United States during the period mentioned scarcely reached one million dollars annually. Beginning about the middle of the century, when California set the pace by adding in a single year fifty, and even eighty millions of dollars to the gold of the world, there followed a steady and increasing progress made in the output of iron, coal, and copper. Railway building progressed on almost parallel lines; so, too, did the deposits in the banks of the United States. It is of interest to note here that the American Institute of Mining Engineers got aboard in 1871, and thereafter shared closely in growth and prosperity this march of industrial progress.

The world's production of gold at the present time is over $450,000,000 annually. The United States alone now produces over 26,000,000 tons of pig-iron annually, and about 550,000,000 tons of coal. The world's yearly production of copper is now over 900,000 tons, and of this the United States produces over 500,000 tons. So, too, we find that the average per capita wealth of the people of the United States has risen from 300 in 1850 to over $1300. The influence of mining on wealth is conspicuously shown in the case of your neighbor, the State of Nevada, where the per capita wealth of her people is about $4800. Nevada is, strictly speaking, a mining state, with easy divorce laws to interest and allure the homeless and distracted mining engineer.

California has added more than $1,600,000,000 to the gold supply of the world. Her record average of over $25,000,000 in gold annually for 50 years is unprecedented. It has been estimated that the actual value of gold deposits should be multiplied eight times to get the true value in credit and capital: If this is true, then California has in her gold supply alone contributed over $12,000,000,000 to the capital wealth of the United States.

Gold is the standard of all values. It is the measure of credit, the basis of exchange. "Change and decay on all around I see," but in gold there is no change, no decay. The lure of gold has discovered continents and turned deserts into fertile lands. Gold was the beaconlight which led Columbus across the Atlantic. Cortez, Pizarro, Balboa, and others who are called explorers were really pioneers and prospectors whose voyages led to the early development of mining in Peru and Chile. But not till California led the way did the mine explorer become a world builder; he was the advance agent of prosperity.

The stability of this country in peace and in war is due mainly to the mining engineer. Our industrial strength comes from the mines, the mills, and the furnaces which are now so well organized on a peace basis and which have in their substance all the sinews of war. Military supremacy comes from the same elements as industrial supremacy: It is mainly a question of organizing the resources of the country. Of one thing we may feel sure and that is that no nation can ever make a scrap of paper out of a gold eagle.

You may crush, you may shatter the coin if
you will,
But the value of gold-dust remains with it
still.

It was because of the recognized importance of the mining and metallurgical industry that the American Institute of Mining Engineers was organized at Wilkes-Barre, Pa., in 1871. Following the War of the Rebellion and coincident with the development of the mining industry in the far western states, there arose a great demand for mining engineers. It was recognized that the chief factor in the development of the Western country was the mining industry: It created a romantic interest and it gave a stimulus to the people in general and even to Congress, which granted large subsidies for railway building. Scientific schools were established and technical journals disseminated engineering literature; but the mining men, those actually engaged in the mines and mills and smelters, were not organized: They needed a common ground for the exchange of ideas, a forum for discussion and education; and so the Institute was established. It was the second society of its kind following the organization of the American Society of Civil Engineers. The Transactions of the Institute cover geology, assaying, milling, smelting, mining, quarrying, and general construction management. The papers submitted at the meetings cover a wide field and are recognized by engineers and scientists throughout the world as of significance and value.

The Institute is incorporated under the laws

of the State of New York, organized and existing with the object of promoting the arts and sciences connected with the economic production of the useful minerals and metals and the welfare of those employed in these industries by means of meetings for social intercourse and the reading and discussion of professional papers, and to circulate by means of publications among its members the information thus obtained. Its membership includes those who have worked their way up from the ranks as well as graduates from scientific schools and colleges. Leading professors and technical educators have always been prominent in its membership. The welfare and safety of the mine-workers is a subject of recent and earnest interest among the members and a new field of usefulness has been developed in using the power and the influence of the Institute wherever the industry represented by mining and metallurgy or the people engaged in the work may be benefitted through state or national legislation.

On behalf of the members of the American Institute of Mining Engineers, numbering now over 5000 and scattered throughout the world, I extend to President Moore, to San Francisco and to California, a full measure of warm congratulations and our best wishes for continued and increasing health, happiness, and prosperity.

THE MANUFACTURE OF LIQUID AIR*

The first real achievement in making liquid air into a commercial article was the patent taken out by Dr. Carl von Linde in 1895. In place of an expansion cylinder which had previously been used he employed a simple expanding nozzle, and made the cooling effect obtained by expansion through this nozzle the basis of his process. The cooling effect is very small, but was found in combination with a good regenerator to be quite sufficient. Actually at 17.1 deg. Cent. there is a drop in temperature of 0.225 deg. Cent. per atmosphere.

The action of the apparatus is simple. Air at a pressure of, say, 100 atmospheres is cooled as far as possible by water, and passed downward through a long spiral of copper tube. At the end of this spiral it escapes through the expanding nozzle, and its temperature at once drops by about 25 deg. Cent. The cooled air then passes up over the outside of the spiral, and in its passage cools the air inside the spiral, which is descending toward the nozzle. The air arriving at the nozzle is therefore colder, and since the expansion through the nozzle makes it colder still, it is clear that a cumulative cooling effect is obtained which will reduce the temperature of the air below the nozzle further and further until it liquefies. In actual practice, using a copper regenerator, Linde obtained liquid air after two hours' running, one fifth of a gallon of liquid air being then obtained per hour. The pressures on either side of the throttle-valve were usually 200 and 50 atmospheres respectively.

It was this apparatus which formed the basis of Linde's patent of 1895 for extracting oxygen from air. Since the boiling point of nitrogen is 195.5 deg. Cent., and that of oxygen 181.5 deg. Cent., or 14 deg. Cent. lower, it seemed probable that if liquid air was slowly evaporated, its two constituents might be separated. In actual practice what happened was that vapors rich in nitrogen and oxygen respectively were given off by two different orifices, and by allowing a rather large proportion of the whole liquid air to escape through the first or nitrogen orifice, a gas containing some 50 or 60 per cent. of oxygen was obtained through the second or oxygen outlet. To accomplish the slow evaporation an extra coil of copper tube was fitted below the main regenerating spiral, and immersed in a small reservoir, containing the liquid air. The air leaving the regenerator passed into the small copper spiral, and gave up the remainder of its heat in evaporating the liquid air in the bath. It then expanded through the nozzle, liquefied, and dropped into the bath surrounding the spiral. Gradually, as things reached a settled state, the liquid in the bath, owing to the difference in boiling points, became rich in oxygen, while the vapors passing off became rich in nitrogen. The liquid and the vapor streamed over different parts of the regenerator on their way to their respective outlets, and the liquid in its passage turned into the gas rich in oxygen, already mentioned. A noteworthy economy in the process is the cooling of the air approaching the nozzle by that which has already passed the nozzle and been liquefied.

*From *Engineering*, London.

Unfortunately this was the best separation which the apparatus could effect, and pure oxygen was not obtained until the brilliant applicaton by Linde, in 1902, of the rectifying tower. Other ingenious improvements, giving increased economy, have since been made by M. Claude, of the Société de l'Air Liquide, and these two apparatus, the Claude and the Linde, are those at present in use. M. Claude's plant is the more economical of the two, but in the smaller sizes requires rather more constant supervision. There has been considerable dispute, not altogether edifying, as to the merits of the two inventions, and the patents have been the subject of much litigation; but there can be no doubt that the two central discoveries on which the whole process rests—namely, the re-evaporation of the liquid air to separate it into its constituents, and the further separation of these constituents by means of a rectifying tower—are due to Prof. Linde. These two inventions are embodied in his patents of 1895 and 1902 respectively. On the other hand, valuable improvements, as explained below, have been effected by M. Claude, and considerable credit is due to him for his researches in connection with neon lamps, liquid oxygen explosives, and the production of exceptionally pure nitrogen. The whole affair, as regards the inventions themselves, was most ably summed up and elucidated by (the then) Lord Justice Fletcher Moulton in 1908, when passing his judgment on the appeal which was lodged by the British Oxygen Company against the British Liquid Air Company.

The action of the Linde oxygen separator for producing oxygen of 98 to 99 per cent purity will be understood by reference to Figs. 1 and 2. The regenerator spiral, as will be seen from Fig. 2, consists of three small pipes *d*, inside a large pipe *c*, one of the smaller pipes *d* being surrounded by a larger pipe *e*. The in-coming air is conveyed by the small pipes *d* to the smaller spiral d_1 which is immersed in the liquid oxygen bath *B*. From this spiral d_1 the air passes by way of the throttle-valve *G* to the top of the rectifying column *A*. Pure oxygen is collected at e_1, and passes through the regenerator by the pipe *e* to the outlet *E*. At *F* nitrogen containing 7 per cent. of oxygen is collected, and finds its way through the main pipe *c* of the regenerator, or interchanger, to the outlet *C*; b_1 is a gage containing a colored liquid to indicate the level of the liquid oxygen in the bath *B*, and *J* and *K* are test-cocks communicating with the liquid air and liquid oxygen supplies respectively. *L* is an emergency release-valve on the low-pressure system.

Before reaching the inlet *D*, which communicates with the delivery of the compressor, the compressed air has been cooled to —20 deg. Cent. by an ordinary refrigerating plant and has been purified of carbon dioxide by a slaked-lime purifier on the compressor suction. The purpose of the forecooler is to freeze out the atmospheric moisture; and if a forecooler is not used, a calcium-chloride drying tower must be placed in the compressor delivery. Even these precautions do not prevent freezing up, so that the forecooler and separator are generally duplicated. In practice, the separator takes about six days to freeze up, and the forecooler about two.

In starting up the plant, air at 2,000 pounds per square inch pressure is admitted at *D*, after being cooled and purified, and passes through the pipes *d* and the spiral d_1 to the throttle-valve *G*, whence it is discharged by the pipe d_2 to the top of the rectifying column *A*. It finds its way out by the collectors *F* and e_1, through the pipes *c* and *e* of the regenerator, to the outlets *C* and *E*. A step down in temperature, owing to the Joule-Thomson effect, takes place at the throttle-valve *G*, and a progressive cooling goes on till the air liquefies and gradually accumulates in the reservoir *B*. The pressure of admission is then reduced by degrees to the working pressure of 50 to 60 atmospheres by opening the throttle-valve *G*.

When the apparatus has steadied down to its work, the liquid air in the bath *B* is continuously evaporated by the hotter compressed air passing through the spiral d_1, the hotter compressed air being thereby further cooled and liquefied. This is in accordance with the description already given of Linde's 1895 apparatus. The vapors coming off from *B* will, as mentioned in the same description, be rich in nitrogen, while the liquid remaining will be rich in oxygen, owing to the boiling point of the nitrogen being 14 deg. Cent. below that of oxygen. We have therefore two opposing streams in the rectifying column; a downward stream which starts as liquid air at 81 deg. Cent. absolute at the top (emerging from pipe

d_2), and an upward stream which starts as a liquid rich in nitrogen at the bottom, being then at about 91.5 deg. Cent. absolute (the boiling point of oxygen).

The action of the rectifying tower and its baffle plates is to change the descending current into oxygen of 98 to 99 per cent. purity, which goes off at the outlet *E*, and to change the ascending current into nitrogen of 93 per cent. purity, which passes through the collector *F*. In the case of the gases ascending, the oxygen is constantly finding itself in contact with liquids, whose temperature farther up the tower grows lower and lower. It therefore condenses, and joins the downward stream as a liquid. At the same time, the nitrogen in the downward stream, which starts as liquid air, coming into contact with gases that grow warmer and warmer farther down the tower, and which are constantly giving off heat, owing to the condensation of the oxygen, gradually evaporates and passes upwards to the outlet *F*. The final result is as stated above; and there is, it will be seen, at each stage of the tower, a constant exchange both of substance and heat. The necessary temperature gradient, between 81 deg. Cent. absolute at the top of the tower, and 91.5 deg. Cent. at the bottom, is obtained by means of the Joule-Thomson effect at the throttle-valve *G*, the pressures on the lower and upper side of this being 50 to 60 atmospheres, and 4 pounds to 5 pounds per square inch respectively. The Joule-Thomson effect also accounts for losses due to leakage through the insulation (which is of sheep's wool cased in with timber) and losses due to the inefficiency of the regenerator. In practice it is found that the pressure of 50 to 60 atmospheres is just sufficient to fulfill all these purposes. It is also far more than is necessary to liquefy the air at the temperature of 91.5 deg. Cent. absolute, which exists in the oxygen bath.

The action of Linde's rectifying tower is similar to, and based on, that of the Coffey still for rectifying alcohol. In the Coffey still the wash, weak in alcohol, was admitted at the top, and steam was admitted at the bottom; while, after rectification, steam passed off at the bottom, and a vapor rich in alcohol at the top, there being, as before, an exchange at each stage both of substance and of heat.

Fig.1.

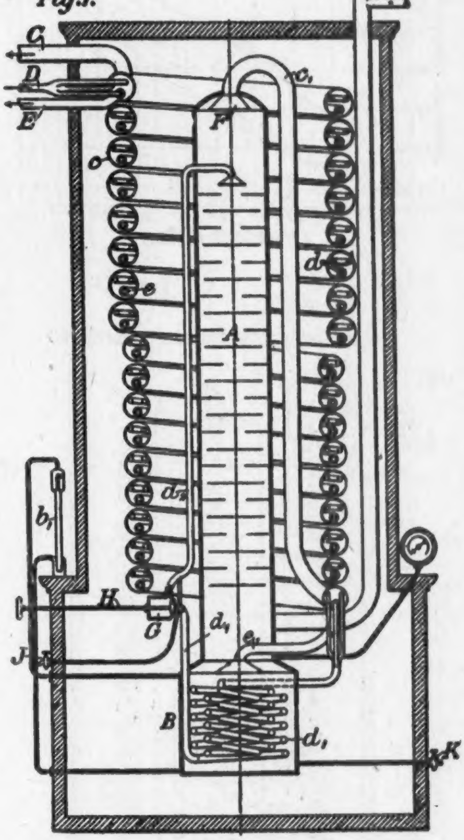
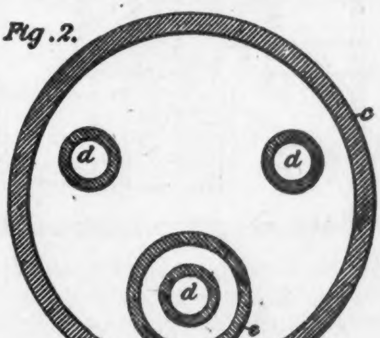
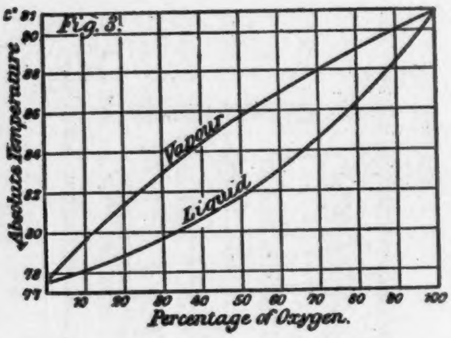
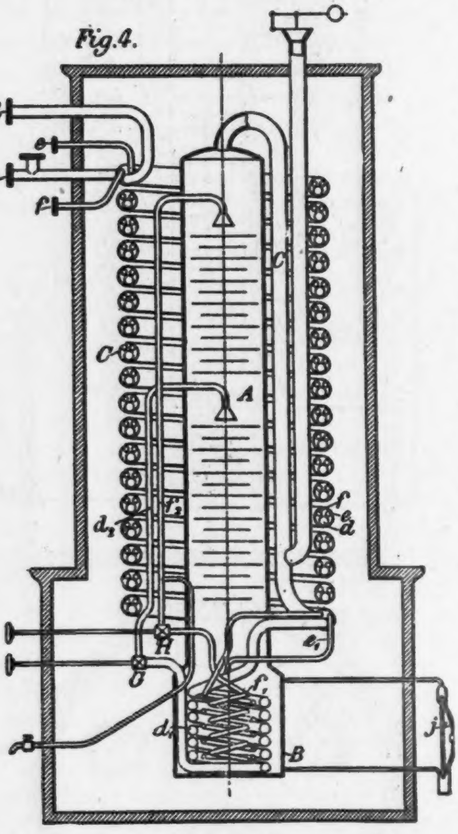


Fig.2.



In Coffey's apparatus the temperature gradient is provided by the excess in temperature of the steam over the weak alcohol wash, and

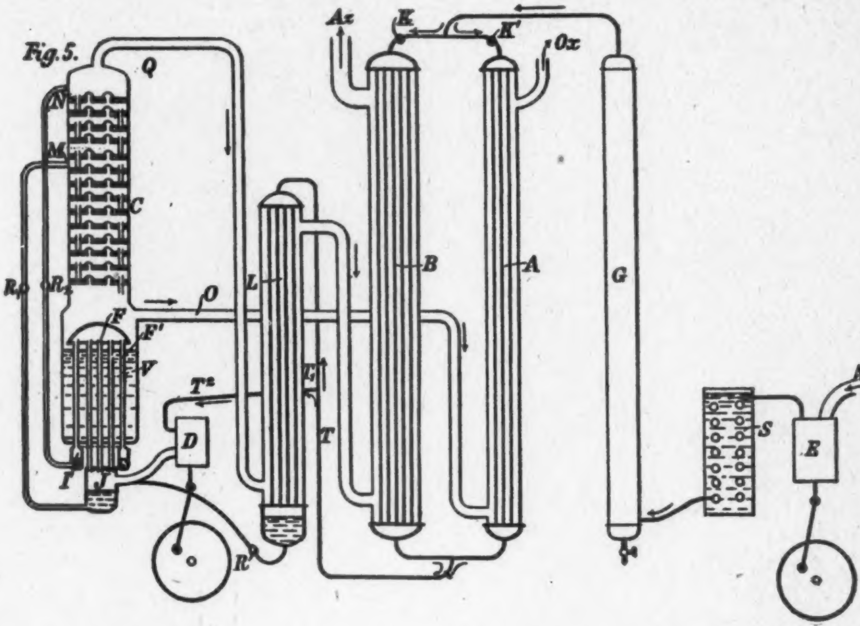




it is in this respect that Linde's apparatus, by using the throttle-valve to give the necessary step-down effect, differs from Coffey's.

It may be asked, Why should nitrogen of only 93 per cent. purity be obtained at the top of the tower? The explanation of this fact, and of the action of the tower itself, will be made clearer by reference to the experiments made in 1900 by Baly, on the nature of the evaporation in liquid mixtures of oxygen and nitrogen. In Fig. 3 the Baly curves, which exhibit the results of his experiments, are shown. Baly found that, given a mixture of oxygen and nitrogen in any definite proportion, equilibrium between the liquid and vapor is possible only when the vapor contains a definite proportion of the two constituents; but this proportion is not the same as that in the liquid mixture. The curves show the percentage which exist in the liquid and vapor respectively at various absolute temperatures. For instance, if the liquid mixture is half oxygen and half nitrogen, the vapor in contact with it will, we see from the curves, consist of 22 per cent. oxygen and 78 per cent. nitrogen. Similarly, when the liquid has the constituency of liquid air—namely, 79 per cent. of nitrogen and 21 per cent. oxygen—the proportion of oxygen in the vapor coming off will be a little less than 7 per cent. For this reason only nitrogen of 93 per cent. purity. can be obtained with the Linde rectifying tower described. And it is also easily seen that, since the ascending vapors are always richer in oxygen than they should be for equilibrium with the descending liquids which they meet, there must be a progressive condensation of oxygen from the vapor, and evaporation of nitrogen from the liquid, to enable that equilibrium to be established.

To meet the demand made for pure nitrogen by the cyanamide process, the Linde apparatus had to be modified, when used for producing nitrogen, to the form shown in Fig. 4, used in conjunction with two compressors, for low and high pressure respectively. The main regenerator spiral *C* incloses three spirals, made from smaller tubing, *e*, *f*, and *d*. *e* conveys the oxygen collected by the pipe e_1 to the outlet *e*. *C* conveys pure nitrogen from the top of the tower to the branched outlet *C*; the pipe *d* takes the delivery of the low pressure compressor to the liquefying spiral d_1 immersed in the oxygen bath *B*, and thence to the middle of the column by way of the throttle-valve *G*, and the pipe d_2; and, finally, the pipe *f* (which is generally replaced by several pipes) takes the delivery of the high pressure compressor to the liquefying spiral f_1, and, by way of the throttle-valve *H* and and the pipe f_2, to the top of the column. As in the oxygen apparatus, a forecooler and



purifiers are used, and there is also a liquid gage *j*.

The preliminary cooling is effected either by charging the plant with liquid air separately made, or by compressing air at 2,000 pounds per square inch into the pipe *f*, and, after expanding it through the throttle-valve *H*, sucking it back again through the pipes *C* and *e*. In actual steady operation air is delivered from the low-pressure compressor at 60 pounds per square inch through pipe *d*, and throttled and discharged by pipe d_2, at the middle of the column, thus rectifying the vapors, which are ascending from the oxygen bath *B*, till they contain only 7 per cent. of oxygen. The rectified vapors escape by the outlet *C*, and a part of them is taken by a branch to the inlet of the high-pressure compressor. From the high-pressure compressor this portion is delivered to the pipe *f*, and discharged as a liquid containing 7 per cent. of oxygen by pipe f_2 at the top of the column. The effect, according to Baly's curves, is to rectify the ascending vapors, which have 7 per cent. of oxygen when they pass the outlet from pipe d_2, till they contain 2 per cent. of oxygen only. A part of the ascending vapors is once more taken from the branched outlet to the inlet of the high-pressure compressor, and discharged by pipe f_2, this time as a liquid containing only 2 per cent. of oxygen. The ascending vapors are thus rectified still further, till finally only pure nitrogen is given off. Part of this nitrogen continues to circulate through the high-pressure system for "scrubbing" or rectification purposes, but the major portion is collected for use through the vertical branch on the outlet *C*. The oxygen vapors meanwhile pass out by pipes e_1 and *e*.

The advantages of Claude's apparatus are, first, that by a progressive liquefaction of the air, he is able to obtain more complete separation than in Linde's oxygen apparatus; secondly, that by using a part of the incoming air to do work in an expansion cylinder, he obtains his drop in temperature more easily, and can do with an initial pressure of 25 to 35 atmospheres only, thus doubly economizing in power. The saving in power amounts to some 20 per cent., but is partially counterbalanced by the complication of the apparatus.

Fig. 5 shows the complete Claude plant. Air, after purification in slaked lime, is compressed and cooled, and passing through the calcium-chloride drier *G*, reaches the two regenerators *A* and *B*. The regenerator *B*, through which the nitrogen passes on its way to the outlet *Az*, is three or four times as large as the regenerator *A*, by means of which the oxygen

arrives at the outlet *Ox*. The air at the bottom of the regenerators has a temperature of about —100 deg. Cent., and is then divided into two parts, about a quarter of it going by way of the pipe T_1 to the liquefier *L*, the function of which will be described later, and the remainder being admitted by a pipe T_2 to the expansion engine *D*. This engine is used to drive a dynamo, and the lubrication difficulty experienced by Siemens has been overcome by the use of petroleum ether. During expansion the temperature of the air falls to about —170 deg. Cent. (103 deg. Cent. absolute), and its pressure to about 4 atmospheres, which is sufficient to liquefy it at the temperature of 91.5 deg. Cent. absolute existing in the bath of oxygen.

Under these conditions the air arrives at the vaporizer *V*. The vaporizer consists of two sets of tubes, *F* and F_1, *all* connected at the top, but opening at the bottom into the receptacles *J* and *I* respectively. Air thus passes into *J*, up the tubes *F*, down the tubes F_1, and into the receptacle *I*, and in its passage it becomes liquefied, the part liquefied in the tubes *F* draining back into the vessel *J*, and the part liquefied in the tubes F_1 draining back into the vessel *I*. Vessel *I* will contain a liquid rich in nitrogen, and vessel *J* a liquid rich in oxygen. This will be clear if we consider that since the liquid condensing on the sides of the central tubes *F* is scrubbed by the up-coming vapor as it trickles down, the liquid and the vapor may be said to be in such close contact as to be in equilibrium. Hence, according to Bayly's curves, since the vapor contains 21 per cent. of oxygen, the liquid must contain 48 per cent. Of course, the liquid formed in the upper part of the central tubes consists mainly of nitrogen, but as it trickles down the interior of the tubes, exchanges of heat and substance take place between it and the ascending vapors, exactly as in the rectifying tower, so that all the liquid arriving at the bottom contains 48 per cent of oxygen. To this draining back M. Claude gives the name of "retour en arriere." When the 48 per cent. liquid is discharged into the rectifying column at *M*, it naturally produces a vapor which has the same composition as air (21 per cent. oxygen), so that the function of the part of the column between *M* and *N* is to take out as much of this 21 per cent. as possible. This is done by means of the liquid from *I*, which consists almost wholly of nitrogen, and is discharged into the rectifying column at *N*. Thus practically pure nitrogen vapor is given off by the pipe *Q*.

If this pure nitrogen vapor at a temperature of 77.5 deg. Cent. absolute were taken direct to the interchanger *B*, it would make the air so cold that it would enter the expansion engine mostly in the liquid state. Hence it is passed first through the liquefier *L*, and in liquefying a part of the compressed air the nitrogen becomes heated itself to —130 deg. Cent. (143 deg. Cent. absolute), and can safely be discharged into the interchanger *B*.

The compressed air liquefied in this way is expanded through the valve *R* into the vaporizer, and is known as the "liquide d'appoint." In practice about one-third of the air is discharged at *M*, and two-thirds at *N*, the *M* supply, as stated above, containing about 48 per cent of oxygen. In the *N* supply the proportion of oxygen is only about 6 per cent.

By a modification of his apparatus, M. Claude has been able to produce nitrogen of exceptional purity for the cyanamide work, such as is turned out by the Linde process already described. The tubes *F* and F_1 in this modification are led into one common receptacle instead of into the two separate reservoirs *I* and *J*. From this receptacle, as before, the liquid rich in oxygen is discharged at a point, such as *M*, into the rectifying columns. But the nitrogen, which condenses with difficulty in the oxygen bath in the ordinary apparatus, is taken off from the top of the tubes, and condensed in a small condenser situated about one quarter or one third of the way up the column, where the temperature is cold enough. It is then discharged as a liquid in a high state of purity at the top of the rectifying column, and rectifies the ascending nitrogen vapor to such an extent that they reach the outlet with a purity of 99.8 per cent.

In conclusion, it is interesting to note that the critical temperature of air, above which it cannot be liquefied, is —90 deg. Cent. (170 deg. Cent. absolute), and the corresponding critical pressure is about 40 atmospheres.

Re-condensed sea-water is the only available supply for the power-plant of the Chile Copper Co. at Tocopilla.

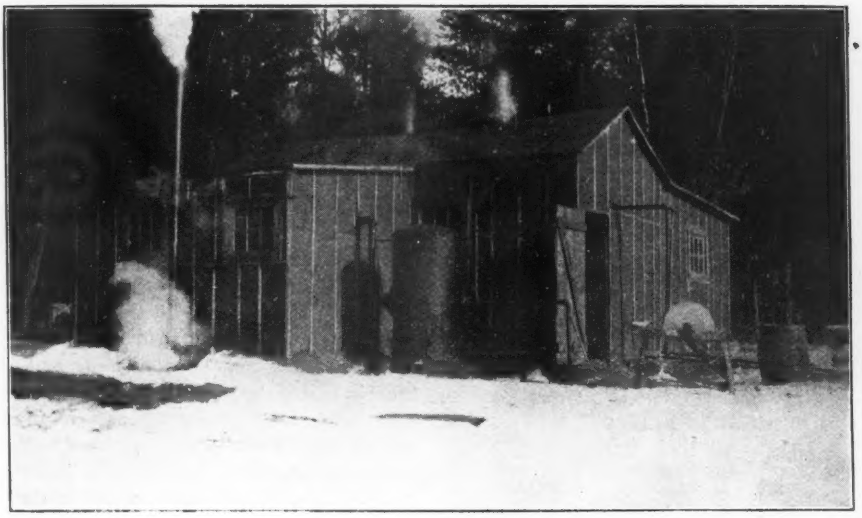


FIG. I. THE COMPRESSOR HOUSE.

THE JACKHAMER IN THE CONTRACTING FIELD

BY A. E. BUZZO.

I have been using a couple of BCR-430 Jackhamer drills in a rather novel manner which shall be described later on. It is my belief that the light, hand-held hammer drills for holes up to about six feet will accomplish more drilling footage than the mounted machines for several reasons: Primarily, as no mounting is required, there is no time lost in setting up. With tripod drills at least thirty per cent. of the working time is lost in moving, setting up, and adjusting. Also, under most conditions, only one man is required to operate the Jackhamer drill, as no helper is needed on the machine. However, as I will state below, due to extraordinary conditions, I have put a helper on each machine in going through a certain formation. Again, since the Jackhamer only weighs about 45 pounds, and rotates the steel automatically, it is easy on the operators and they enjoy the work more.

For about the first 600 feet on this job we encountered granite, which was of a pretty uniform character. This was comparatively light and easy work for the drills. Then we ran into a quartzite formation, which was extremely hard and very much fractured. This made it difficult to get holes to the required depth (most of the holes were drilled to 6 feet). There is where the Jackhamer drills showed their superiority over the heavier piston machines. When we ran into a split in the rock we simply had to stop and start another hole. With the Jackhamer it only took a few seconds to make the change, while with the tripod drill it would have taken at least 10 minutes, and, in our case, many times it would have taken considerably longer. Also, as we were always working in from 12 to 30 inches of water, it will readily be seen that it was easier to handle the 45 pound machine than to flounder about with the heavy tripod drill weighing five or six times as much, especially as we know that the smaller machine will drill as fast as the larger one when supplied with a good air pressure. We carry about 100 pounds air pressure, using a 10 and 10x10 in. Ingersoll-Rand straight line steam driven compressor. Incidentally, I have also used the Jackhamers operated with steam, and have found them very satisfactory; but I prefer the economy and good results obtained from the use of air for any large job.

As the rock was covered most of the distance with sand and gravel, we had to use a casing to protect the collar of the hole from sand washing in. We, therefore, shrunk a steel ring loosely on the collar of the drill steel, and over the 2 inch casing. The ring was loose enough on the collar so that the steel would not bind in the hole. We used this method going through the worst forma-

FIG. 2. DRIVING THE CASING.

tion, but as the rock was so badly fractured, I had to put a helper with each drill. He used a Stillson wrench to keep the steel rotating when it had a tendency to stick.

Of course, on account of these difficulties, a great deal of the men's time was taken up keeping the steel cutting properly, and, therefore, the drilling costs were much higher than they ordinarily would have been, and it is rather difficult to arrive at a definite cost figure. Yet, taking all obstacles into consideration, I figure that the Jackhamers have enabled me to do the drilling at about one-half what it would have cost me had I used the big machines. I have three 2½ in. piston drills here but did not attempt to use them against the Jackhamers.

This is a private drainage job designed to open up some fertile agricultural lands. During the winter the temperature was often 20 degrees below zero. We had some trouble with the hollow steel becoming blocked and freezing, but overcame this by keeping a fire handy and thawing it out. We took care not to heat the steel enough to draw the temper out of the bits. We used steel having the four-point cross bits, which gave sufficient clearance for the cuttings. I find the steel-retaining spring very handy when withdrawing the steel, also in keeping the hole free by churning the steel up and down; and the method

FIG. 3. THE JACKHAMERS AT WORK.

of keeping the bottom of the hole clear and throwing out the cuttings by means of exhaust air, is admirable.

My repair costs have been negligible. My blacksmith paid particular attention to having the shanks of the steel square for the piston to hammer against, so that the tendency of the ends of the piston to chip off is quite eliminated. It has been my experience that even the much abused rock drill must be treated fairly well in order that it may give the best account of itself.

Aside from drilling rock, I found the Jackhamer very useful in the shop. We made a drag line bucket on which there was considerable riveting to do. Amongst my equipment I had another drill which was lying idle in the shop. In putting a patch on the dredge, the blacksmith had tried this drill for driving the rivets, and, at the same time, unknown to me, he had tried one of the Jackhamers. The Jackhamer proved very successful and he discarded the former machine. For the bucket job referring to, the blacksmith made a tool with a smooth surface, analogous to a blank rivet snap as used with a pneumatic riveting machine. The operator simply worked the Jackhamer around the rivet at different angles. We had air pressure on the forge and then it was all one man could do to furnish hot rivets to keep the Jackhamer going.

A JACKHAMER IN THE GOVERNMENT PRINTING OFFICE

BY W. R. METZ.*

The Drill mentioned herein was purchased under date of May 26, 1914, and has been in almost daily use up to the present time without having been sent to the shop for repairs and without being out of commission at any time.

On one occasion I had to remove a chimney foundation constructed of hard brick made in cement mortar. This foundation was twenty feet square by ten feet deep and was so hard that the bricks split before giving away at the joints. Three drills were used on this job, two being of another make, non-rotating, and one a Jackhamer with the rotating feature. The method used was to drill a row of holes, then drive wedges into the holes and split out sections. On account of the necessity of installing new machinery a new steel and concrete floor had to be constructed at a point directly above the top of the chimney base before the old foundation could be removed, so that the ordinary method of attacking the foundation from the top could not be adopted and the holes had to be drilled from the sides. The refuse material had, therefore, to be taken out of the basement in small trucks and up an elevator, which necessarily increased the cost of the work. The entire work was done at a cost of $15.00 per cubic yard, which was considered reasonable under the conditions. On account of the non-rotating feature the two other drills mentioned above required two men while the Jackhamer with its rotating action required only one man. The two other drills were also slower, requiring nearly twice the time to drill a hole 12 inches deep as did the Jackhamer. The Jackhamer drilled a 2 inch hole in three minutes, using fifty pounds air pressure.

This machine has also proved useful in drilling holes through the floors and ceilings of the building. The floor construction is of concrete and brick arches, with a two-foot space between the lower part of the arch and the ceiling below, this ceiling being constructed of concrete tiles. The space between the floor and the ceiling is used for carrying piping, electric wiring, etc., and it is, therefore, often necessary to drill a number of holes for installing machinery and lights, and the Jackhamer has long since paid for itself in this work alone. On floor work one man can drill a hole through the floor arch in two and one-half minutes, this arch being about ten to ten and one-half inches thick. On ceiling work it required two men on account of working on ladders or staging.

Another use of the Jackhamer is in replacing damaged bars or rods in chain-grate stokers. In our boiler house we use Babcock & Wilcox type chain-grate stokers, the general construction being small grate castings held together with one inch diameter steel rods, these rods extending the full width of the grate. In removing a damaged casting it is only necessary to drive out the rod, following up the same with a new rod, replacing the casting with a new one and driving the new rod clear through. This work was formerly

*Supt. of Buildings, Government Printing Office, Washington, D. C.

done with heavy lead hammers and took about ten minutes to replace a rod; the work is now done with a Jackhamer in about two minutes. In this work the rotating feature is not necessary, but mention is made as I believe this is a new field for Jackhamer use.

One of the main features of the Jackhamer and one of its best features is that it can be operated by air as well as by steam, and comparatively low air pressure can be used without serious disadvantage. For example: our building is piped up for air service in which air is carried at fifty pounds pressure. It would be a difficult matter to pipe up a building with outlets for hammer drills at each floor for high pressure steam..

This machine is certainly one of the handiest devices I know of for general use around a manufacturing plant and a machine driven by air as well as by steam and with the rotating feature, will pay for itself several times over in a single year.

BURNING OF ACETYLENE IN MINERS' LAMPS

When acetylene gas burns in air the gases given off by the flame consist of carbon dioxide (CO_2), and water (H_2O) in the form of steam, neither of which can be seen. In burning 1 cubic foot of acetylene, 2½ cubic feet of oxygen, or 12½ cubic feet of air (about 1 pound), is required; the products are 2 cubic feet of carbon dioxide, and 1 cubic foot of steam. As ordinary air is a mixture of oxygen and nitrogen and contains about 20 per cent. of oxygen, 10 cubic feet of nitrogen is left from the 12½ cubic feet of air needed to burn the cubic foot of acetylene.

The ordinary types of miners' carbide cap lamps use 12 to 14 grams (0.42 to 0.5 ounce) of carbide in an hour, and make 0.121 to 0.144 cubic foot of acetylene gas. In burning 0.144 cubic foot of this gas, 0.36 cubic foot of oxygen, or 1.8 cubic feet of air, is required, and there is given off by the flame 0.288 cubic foot of carbon dioxide.

In one hour the lamp in a confined space measuring 3 by 5 by 10 feet, or 150 cubic feet, would take from the air 0.36 cubic foot of oxygen, and add 0.288 cubic foot of CO_2, which, added to the 0.006 cubic foot (or 0.04 of 1 percent.) of CO_2 in 150 cubic feet of ordinary mine air, would total 0.294 cubic foot, or 0.196 of 1 per cent. of CO_2. In 10 hours 2.88 cubic feet of CO_2 would be added; this added to the 0.006 cubic foot of CO_2 normally in the air would make 2.886 cubic feet of CO_2, and the atmosphere in the space would contain 1.9 per cent. CO_2 and about 16 per cent. oxygen.

In unventilated parts of mines the diffusion of the gases in the air would prevent the CO_2 from the lamp becoming a dangerous quantity during a working shift.

A miner at moderate work draws into his lungs about 80 cubic feet of air in an hour and takes from this air about 3.2 cubic feet of oxygen; he exhales about 2.56 cubic feet of carbon dioxide, or over 8.8 times as much carbon dioxide as is given off by the flame of a carbide lamp.

Miners' Circular 18, *Bureau of Mines*

GUNITE FOR MINE WORK

BY STEPHEN ROYCE.*

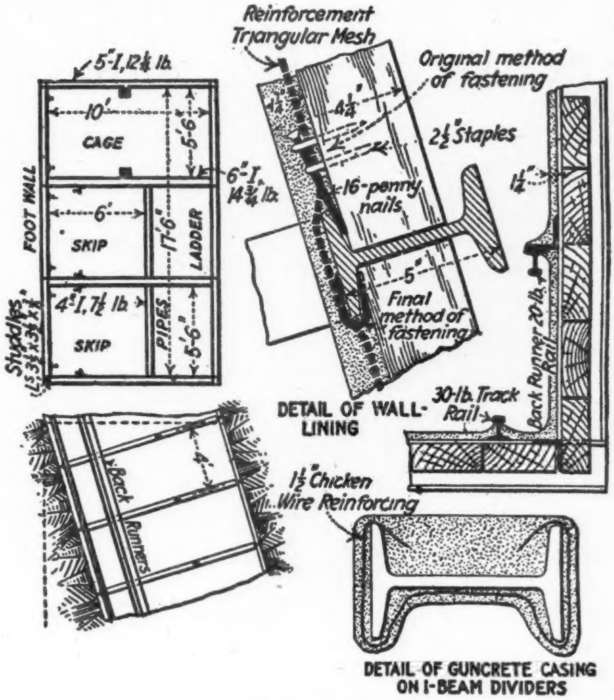
The application of Gunite, or "Gun-crete" as it has been called, to mining operations is comparatively recent. Gunite may be defined as a mixture of sand, cement and water blown on a solid surface by compressed air forcing it through a hose and nozzle. An essential part of the gunite coating is the use of some form of reinforcing wire to be applied to the surface to be coated before the cement is blown on.

The places in which gunite has been used on the Gogebic range are the Cary "A" shaft, at Hurley, Wis., and the 18th level pump house of the Sunday Lake mine, Wakefield, Mich.

The cut shows a cross section of "A" shaft, and a longitudinal section, as well as details of the method adopted in applying the cement coating and its reinforcing. "A" shaft is a steel 5- compartment shaft, sunk to a depth of 1320 ft. in the quartzite. The steel sets are blocked in place with wooden blocking, and the lining of the shaft consists of 3-in. tamarack plank wedged into the flanges of the I-beams, which form the wall plates and the end pieces.

The purpose of the gunite coating in "A" shaft was, first, to fireproof the lathing and wooden blocking; second, to protect the lath-

*General Engineer, Pickands, Mather & Co., Gogebic Range. Proceedings Lake Superior Mining Institute.



GUNITE IN MINE WORK.

ing from contact with the air in the shaft, so retarding its decay; third, to form an air and waterproof coating over the shaft lining, keeping air from entering the space between the timbers and the rock, and keeping in the water which is flowing along in the same space. This last feature is expected to retard the decay of the blocking as well as the lathing as this will be water-logged all the time. The gunite coating, by reason of its wire reinforcement, is expected to reinforce the lathing and partially take its place in the event of decay actually occurring. The coating was applied not only to the walls of the shaft, but also to the steel dividers, the intention being to protect these from rust and incidentally reinforce them after the manner of a reinforced concrete beam.

At Sunday Lake the purpose was to fireproof the pump house, which is timbered with heavy wooden posts, caps and lagging, and to protect the wood from dry rot, which at the high temperature in the pump house, quickly attacks it.

The application of the gunite coating in "A" shaft was done in two experimental sections, one being from the collar of the shaft to the 3rd level, the other from the 8th to the 10th level. In the first the machine was placed on surface and the hose lead down through the shaft to the point of application; in the second the machine was placed on the 8th level.

The first step in the application of the coating was to clean thoroughly the entire surface to be covered, which was done partly with water under heavy compressed air pressure, partly by sand blasting and partly by chipping the rust and accumulated coating off the steel. Next the reinforcement was applied. . This consisted of No. 7, American Steel & Wire Co.'s triangular mesh reinforcing wire for the side walls.

An important point in the application of the reinforcing wire is that it should be separated by a short distance, say one-eighth of an inch, from the surface to be covered. This is so that the cement can get in behind the reinforcing and form a unit with it. This was accomplished by stapling the reinforcing

wire on with nails under it. The I-beams, before the cement was applied, were covered with 1½-in. mesh chicken wire, clamped on with wire clamps. The dividers were filled in completely on their upper faces resulting in their reforcement for bearing a downward load. This increase in strength we figure at nearly 20 per cent. The work progresses downward and it was found best to coat the entire sidewalls before coating the dividers. The thickness of the coating in "A" shaft was 1½ ins. and it was found that the operator was able to gauge this thickness with astonishing accuracy. The cement was applied in from two to three coats.

The Sunday Lake pump house was coated with 1½-in. coating of gunite, over all the posts, lagging and exposed timber. This was applied over a reinforcing, consisting of 1½-in. mesh chicken wire on the posts, and a No. 7 reinforcing wire, triangular mesh, on the lagging in the roof.

The results so far observed have been excellent in both places. In "A" shaft we have a hard, fairly smooth, waterproof coating, which does not crack with the jar of the shaft in hoisting, and which we believe will greatly prolong the life of the shaft at the points where it has been used.

An interesting feature of our use of the cement coating is the wide difference between the temperatures to which it is subjected. At the collar of "A" shaft the cement is covered with frost and subjected to a temperature considerably below zero. In the Sunday Lake pump house the temperature at 5 ft. above the floor is 111°, and this must rise greatly near the roof of the pump house.

The cost of lining "A" shaft as described came to $9.2978 per linear foot of shaft. The total area of wall surface covered was 14,260.90 sq. ft., the total area of steel covered, measured along the contact of the cement with the steel was 3749.96 sq. ft. The material used was as follows: Sand, 102½ cu. yds.; cement, 173 bbls; reinforcing, 14,260.90 sq. ft.; chicken wire, 3749.96 ft. Fastening staples and wire were also used.

The work was accomplished by one foreman and six men in 32 working days. The total linear feet of shaft covered was 263.13. The Sunday Lake pump house, which was done under especially hard conditions, was considerably more expensive per square foot. This was done on contract by the Cement-Gun Construction Co. of Chicago. "A" shaft was an easy shaft for the application for the cement-gun coating as there was comparatively little water flowing on the surface of the lathing which was to be covered. If the cement can once be applied and can harden, no amount of water will make any difficulty thereafter, but there are considerable difficulties in making the coating stick to a wet surface.

GROWING USE OF COMPRESSED AIR IN COAL MINES

Experience suggests that there is a tendency with quite a number of colliery engineers to again revert to the use of compressed air underground in preference to electricity, as it is being more generally recognized that the air compressors of the present day are a very different article from the type of air compressors installed twenty or thirty years ago. The higher efficiencies obtained and the better training that the present-day engineers have, make them more alive to the arrangements they must provide in collieries for the efficient use of compressed air. The plant, therefore, now installed in any up-to-date colliery is in itself better suited to its conditions, and the air which it may deliver is used in a much more efficient manner. With these two leading differences, there is no doubt whatever that there has been, and is likely to be more so in the future, a tendency to have more and more air used in underground work, and especially where there is danger from gas or other reasons likely to cause explosions, such as may take place through any accident or other cause in the use of electrical plant under similar conditions.—*Colliery Guardian, London.*

In the hottest weather of the summer there is special trouble in the printing offices of the great newspapers and elsewhere. This is because of the softening of the gelantinous inking rollers, and arrangements must be made to keep them cool. An electric driven fan ventilating set, built by the B. F. Sturtevant Company, is proving highly satisfactory for the purpose and is being extinsively employed.

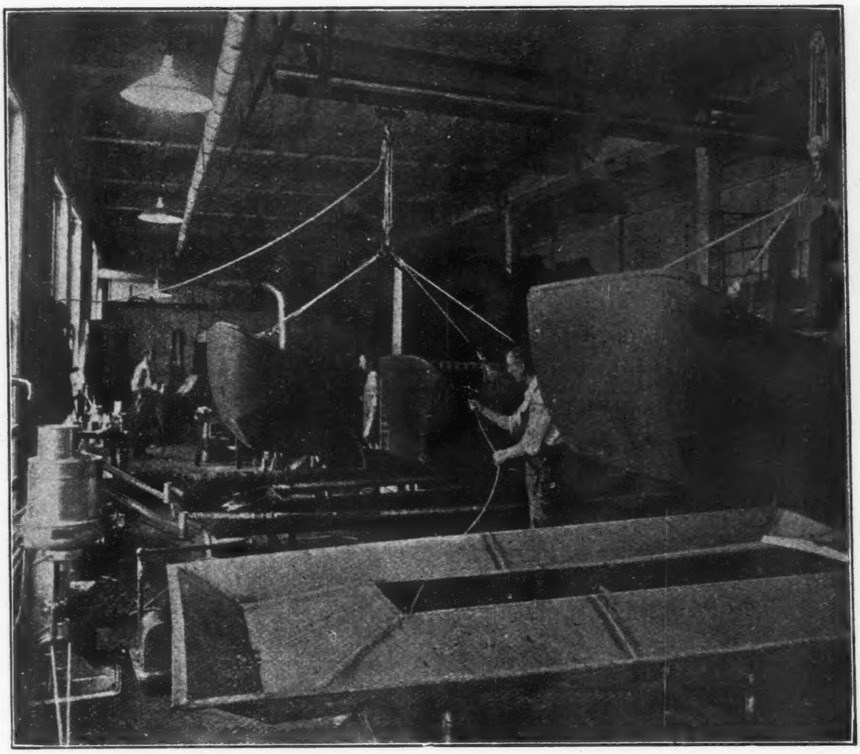


FIG. I. VARNISH APPLIED BY FLOWING NOZZLE.

COMPRESSED AIR FOR FINISHING THE AUTOMOBILE

BY GEORGE D. BABCOCK.*

In line with the modern improvements of machinery and methods for mechanical work there has been a development no less marked in the art of applying decorative and protective coatings to various surfaces.

Applying coatings with an atomizing air brush has only within the last two years reached a prominent position in industrial work. More recently still, in fact practically a development of the last year, has come the process of stream flowing of varnishes. This process is the application of liquid coatings by means of a wide flat nozzle through which the coating is forced to flow continuously upon the surface in a wide ribbon-like stream.

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*Production Manager, H. H. Franklin Mfg. Company, Syracuse, N. Y., builder of the Franklin automobile. Article condensed from Iron Age, Oct. 7, 1915.

As in all new processes skepticism early took the place of scientific study, and the question of durability, cleanliness and brilliancy were long debated before the present practical adoption of the methods. The virtue of these late methods has been proved conclusively for each of the above-mentioned points.

The protection of the exposed surfaces of automobiles from the elements affecting them has required most intensive study since the beginning of the industry. Different kinds of soils, as well as different conditions of air, do not act alike on protective coatings. The continuous exposure of these coatings on the automobile requires that they be not only perfectly prepared and applied, but selected to resist the special destructive influences.

Japanning or painting aluminum surfaces presents now no particular problem to secure permanency and luster. Steel and wood have long since ceased to be troublesome.

Ten-day rubbing varnishes are dried in four and one-half hours with improved luster, cleanliness and durability.

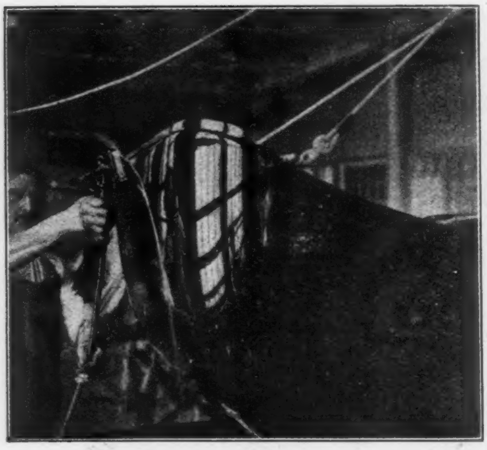


FIG. 2. FLAT STREAM CLEANS AND VARNISHES.

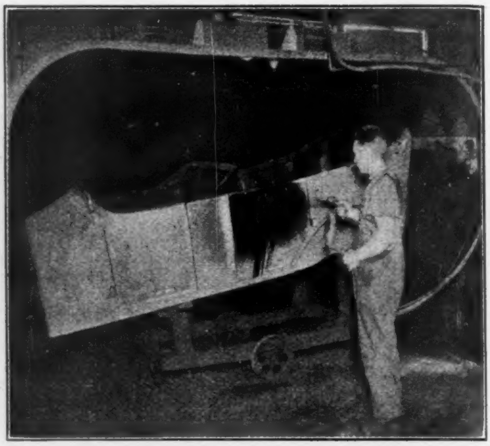


FIG. 4. HOOD FOR AIR BRUSH PAINTING.

The flowing of varnishes with the nozzle method leaves a coating as thick as will adhere to the surface.

Air drying required many coats relatively thin. High temperature drying, with humidity control and frequent air changes, gives better results by a thoroughly oxidized, tough, thick, varnish film. After such drying the film does not seem to crack or "alligator" as do numbers of thin air-dried coats.

Figs. 1 and 2 show how the flowing of the automobile body is done. Brewster green color varnish is used with the DeVillbus Floco equipment. The top outlines of the body are first brushed, to prevent spattering on the interior, and then the wide flowing nozzle is passed over the entire surface until the varnish not only washes off any dirt upon the surfaces, but flows in a thick uniform coat. The body is then allowed to drip and after a short period of air drying is put into the drying ovens, Fig. 3, which are heated and humidified by the Greeff Engineering Company's equipment. This varnish coat dries in four and one-half hours. The varnish which drips from the body flows back through a filter into a retainer, and at frequent intervals it is separated by means of a De Laval Separator, as shown in Fig. 1. This cleanses the varnish and it is used repeatedly; the new varnish being continuously added to that in use. In the far rear of Fig. 1 is shown the so-called rough-stuff coating of the hoods by means of the atomizing air brush, after which they are coated by flowing as are the bodies.

Fig. 4 shows how the lead coat is applied with the DeVillbus atomizing air brush. A ventilating hood covers the work to take off the fumes. In the rear of the hood is the electric suction fan, and at the top of the hood may be seen the electric lamp enclosures for close illumination. One hose to the brush leads from the air pressure tank and the other from the liquid finish to be

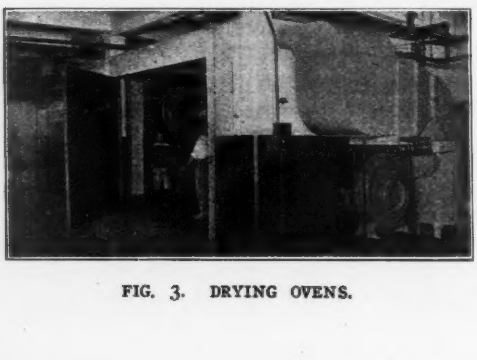


FIG. 3. DRYING OVENS.

FIG. 5. PARTS CARRIED ON TROLLEYS.

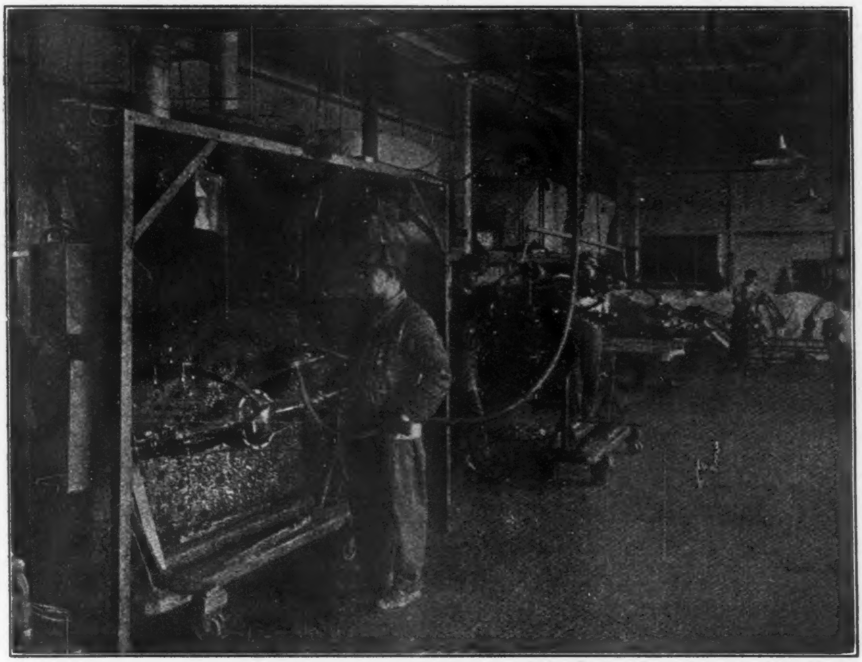


FIG. 6. AXLES CARRIED ON SPECIAL BUGGIES.

applied. The air brush spray is moved rapidly over the surface and gives a smooth uniform stippled coating. (The run, as it is called, shown in the photograph, was due to the operator's holding steady for the photograph.)

Wheels are charged to an air brush hood by means of the rolling conveyor as shown on each side of the hood in Fig. 7. After the varnish coats are applied the wheels are placed in a revolving dryer, where the varnish is allowed to set by air drying. The uniformity of the coat is maintaned by the continuous rotation of the wheels. After air drying, the wheels are heat dried in ovens.

Fig. 6 shows how the axles are finished, all coats being given with the air brush.

Japanning plays an important part in the protective coatings of an automobile. After dipping in the japans, the parts are hooked upon trolleys, as shown in Fig. 5, suspended by brackets from the ceiling and allowed to drip over the pans. They are then run into the drying ovens and baked. The indirect Gehnrich ovens, shown in this illustration, do not allow the burnt gases to act upon the japans. All products of combustion are carried up the sides of the ovens in the tubes as shown. There are no draughts needed in the oven to maintain the burning gas, and therefore none of the dust from the room is carried into the oven and deposited on the work.

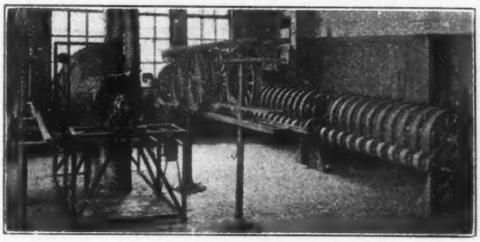


FIG. 7. ROTATING WHEELS FOR DRYING.

Poona is a mountain sickness that attacks people at an altitude of 11,000 ft. in the Andes of Argentina. These mountains are quite different to the Sierra Nevadas in North America. A height of 10,000 ft. is trying in the Andes, but in Mexico this elevation is unnoticeable.

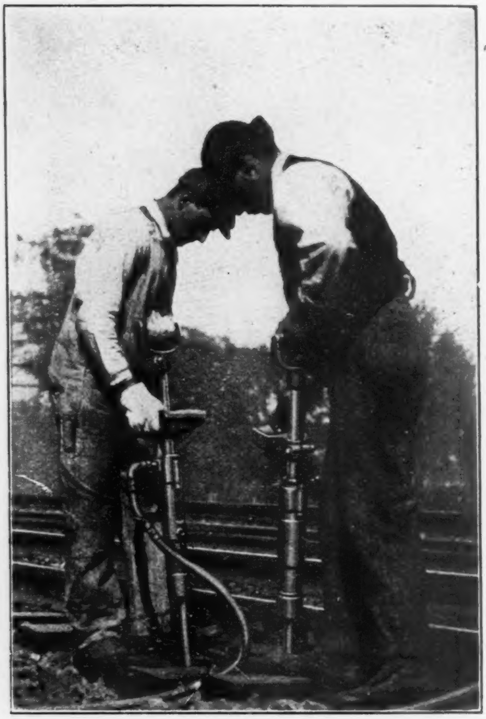


FIG. I.

THE PNEUMATIC TIE TAMPER*

BY W. H. ARMSTRONG.

We are probably well agreed that the tamping of rock ballast is the most arduous and fatiguing of track work. I am to direct your attention to a new track appliance which relieves the track laborer of his most strenuous and unwelcome task, and gives a better and more uniform quality of work at a great reduction of cost.

The Pneumatic Tie Tamper here to be spoken of is operated by compressed air at ordinary pressures, and works on the principle of the familiar pneumatic riveter. There is a piston or hammer which delivers sharp blows as rapidly as 800 per minute on the end of the tamping bar or steel which is inserted in the nozzle or lower end and is held in position by a secure locking arrangement which prevents its knocking out and also enables the operator to lift it from one position to another as is constantly required in the progress of the work.

The face end of the tamping bar or steel is similar to the tamping face of the ordinary hand tamping bar or pick. That is it is, say, ½ in. thick and 3 in. wide for heavy rock ballast; ⅞ in. by 3 in. for crushed stone or gravel, and 1⅛ in. by 3 in. for cinder or dirt ballast.

In operation the face of the tamping bar remains upon the ballast while the hammer blows are showered on the upper or shank end of the bar, and the action is to shove what ballast is covered by the face of the bar under and to the center of the tie. Then it is lifted back and the operation is repeated until the ballast is filled solid under the entire length of the tie. The best results are obtained by working the tampers in pairs or upon opposite sides of the tie at the same time as shown in Fig. 1. The method in this respect is practically the same as when using the old tamping bar.

The tamping machine complete with the tamping bar weighs 37½ lb., and as it is always held in a nearly vertical position the weight is sufficient feed for it without exertion on the part of the operator. The weight also absorbs the vibration of the machine, thus making it very easy to hold. The machine has two handles so located as to balance it to the correct height and position and enables the operator to stand erect while working.

The men like to use the machines as they find them much easier than the hand tamping bar or picks. When I questioned a track laborer on this point, the other day, he said, "I like best the machine because it no make me sick in the back."

The machine tamping is much faster than hand tamping. Two men should tamp a tie at both sides, inside and outside the rail in two minutes. It is more uniform, because the blows are just the same all day long, and, the blows being struck on the upper or shank end of the bar, it can be inserted between switch points, under frogs and around interlocking switches and do good and effective work where it is impossible to tamp properly with

*Condensed from Paper before the Roadmasters and Maintenance of Way Association.

FIG. 2.

hand picks or bars. Fig. 2 was taken in the tunnel of the Hudson & Manhattan Railroad in New York.

It may be claimed as an additional recommendation for the air tampers that, aside from their working faster and doing better and more uniform work, they do not crumble or break up the ballast as badly as the hand picks, nor do they sliver the ties.

In terminals and car yards and at other points on railroads where electro-pneumatic signals are in use, or where charging air lines are maintained, the machines can be operated successfully from these air lines without interfering in any way with the signals or other work, and also with good economy, due to the fact that the portable compressor is dispensed with.

For outside or line work where there is no air on tap, there is provided a gasoline-driven air compressor plant which is self contained and self propelled, taking the place of a section motor car and capable of being shifted off or on another track in the same way. It will carry twelve men at a maximum speed of 15 miles per hour. The gasoline engine is 12 h.p. and the compressor will easily supply two of the tamping machines.

For electric railroads and for street railways an electric driven outfit takes the place of the gasoline machine.

The first experiments with pneumatic tampers of this type were conducted on the West Shore Railroad of the New York Central Lines. With two of these machines they tamped 800 ft. of track at Granton Station, River Division, and an equal distance on parallel track was tamped by hand. This was not an ideal location for a trial of this kind as the foundation was built over the Hackensack Meadows, and consequently was soft. This was before the portable air compressor had been developed and the location was selected as the only place where air was readily available.

A careful examination of the two portions

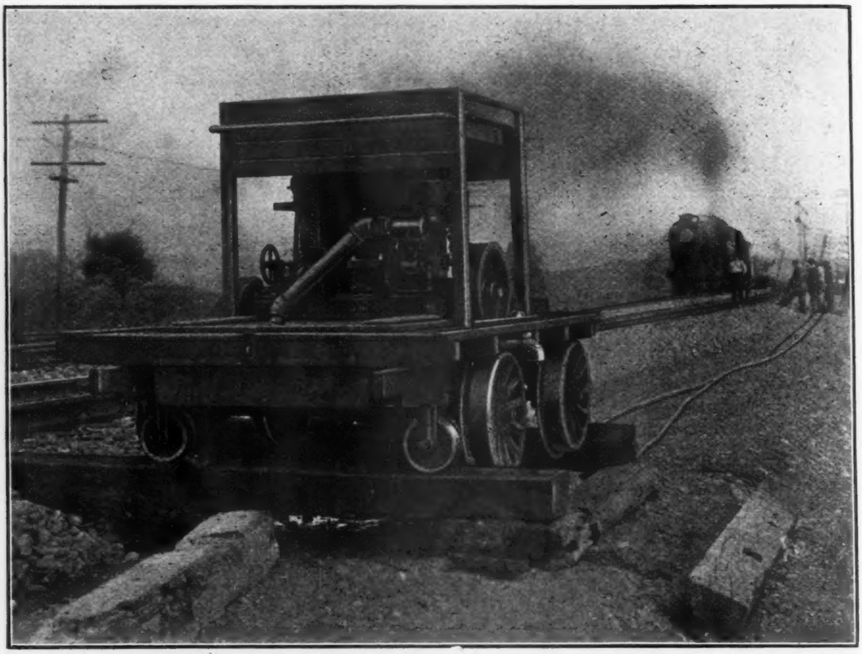


FIG. 3.

of track six months later showed the following results, the track settlement being noted in fractious of a foot:

	Greatest.	Least.	Av'g.
Hand tamping	0.116	0.018	0.067
Machine tamping	0.063	0.004	0.033

It was found that it is not absolutely necessary to clean the ballast out at the bottom of the tie, as must be done when tamping by hand, as the pneumatic tampers will work down through the ballast.

Further tests were made by the New York Central Railroad, employing one of the portable compressors and two tamping machines, and the impressions gained from the first test were fully confirmed. It was determined that the pneumatic tamper is thoroughly practical, that it does more uniform, more lasting and in every way better work than is possible to be done by hand, that good tamping can be done in contracted spaces, as in frogs, interlocking switches, cross-overs, etc., that it is unnecessary to remove tie and switch rods as the tampers work around them easily, that there is less injury to the ties from slivering and less crumbling of the ballast.

The New York Central purchased twelve of the complete portable compressor outfits, with tamping machines, hose, etc., and these were put into operation on several sub-divisions. A record was kept of the performance of each plant and the average accomplishment of the twelve is summarized as follows:

Hours per day	7.0
Ties tamped per day	177
Ties tamped per hour	26
Single track covered per day	316.8 ft.
Single track covered per hour	45.7 ft.
Gasoline used per hour	1.37 gals.
Gas Engine oil per hour	0.24 pt.
Compressor oil per hour	0.10 pt.

The work performed covered all classes: tamping track in face, tamping while lifting track from 1 to 6in., tamping cross-overs, etc. Two men are employed for the actual tamping while a third man forks up the stone and dresses the ballast. The latter also attends to the running of the compressor and interchanges with the others. It was found that three men thus employed will do more and better work than eight to ten with tamping picks or bars.

SHAFT SINKING WITH JACKHAMERS

BY LEROY A. PALMER.*

At the Black Oak mine in the "Soulsbyville granite" near the Mother Lode, jackhamers have replaced piston machines in shaft-sinking with a reduction of costs, air consumption, etc. Delay-action exploders have also been of assistance in sinking this shaft.

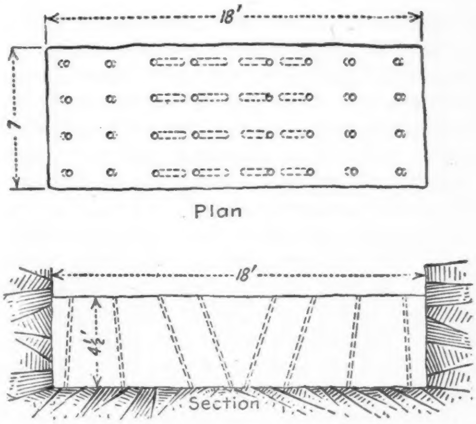
To the miner of the Mother Lode and the adjacent districts "Soulsbyville granite" conveys a meaning that cannot be amplified by a wordy description. This rock is a typical gray granite, shading into grano-diorite and containing intrusions of diorite. It is extremely hard.

The Black Oak mine is situated a mile from Soulsbyville in this granite area and is operated through a shaft which has just reached the 1900 level, work on sinking the sump being now in progress.

The shaft was carried to the 1600 level with piston machines; then it was decided to try jackhamers. Inasmuch as a careful comparison of the work of the piston machines in sinking from the 1500 to the 1600 with that of the jackhamers in sinking from the 1600 to the 1700 was in favor of the latter, the work was continued with the lighter machines. The piston drill was a standard type of 3-in. machine.

Four men were used on a shift in each case —in the one, on two piston machines, and in the other, each with a jackhamer—and it was found that the daily progress was increased approximately 25% by using the jackhamers. No attempt has been made to formulate a comparison of the air used but is is known that the four jackhamers consume less than the two piston machines.

The shaft consists of two compartments and a manway, being 7x18 ft. overall and 5x15 ft. in the clear. It is on a very steep incline which averages from 65 to 70 deg. An ideal round, drilled to break 4½ ft., is shown in the illustration. It consists of 32 holes, two sets of cut-holes, eight to a set, and two sets of side rounds of the same number. The procedure is to put in the inner cut-holes, blast them and muck out before drilling the



rest of the round. The outer cut-holes and the side rounds are then put down and, if there is time, as is usually the case, another set of shallow cut-holes is drilled in the sump formed by shooting the first series of cuts. It has been found that this system of breaking the cut, then deepening the cut and shooting with the remainder of the round, has increased the progress of sinking about half a foot per round.

Drilling and mucking of the inner cut-holes is all done on one shift by four men. The next two shifts are given over to the muckers who clean out the shaft and get it ready for the drillers. The mucking shifts consist of two muckers and an engineer for the donkey hoist on each shift.

Of course the placing of the holes is varied to suit conditions as they are found in the shaft and it sometimes happens that as many as 25 holes are put down for the side rounds but the illustration shows a typical round. In all of the holes 60 per cent. dynamite is used.

The present arrangement of doing all drilling on one shift and mucking on the other two has been very satisfactory. It calls for a total of 10 men including an engineer on each of the two mucking shifts to hoist the broken rock from the bottom of the shaft to the 1600, where it is user for filling. The same headway has been made thereby as previously when there were four miners on each shift, drilling or mucking as occasion required.

The men are paid on a bonus system. The regular wages are $3.75 per day to one of the

*Mining Engineer, 512 Custom House, San Francisco, Article reprinted, somewhat abridged, from Engineering and Mining Journal, Oct. 9.

miners who acts as shaft foreman, $3.50 to each of the other miners and the engineers, and $2.75 to the muckers. The miners each receive 25c. a day bonus for every month in which the shaft is sunk over 60 ft. and the muckers the same allowance for every day that they get the shaft cleaned out on time for the drillers to go to work.

During March, 1915, the shaft was sunk under the old arrangement of shifts, four miners on each shift drilling or mucking as the case might be. During this month the cost of sinking was $35.56 per ft. In April the shifts were rearranged, as noted, so that all drilling was done by miners on one shift and the shaft cleaned out by muckers on the following two shifts. For the first week under this arrangement of shifts the costs were brought down to $27.00 per ft. These are what the management refers to as "direct costs;" that is, cost directly chargeable to the shaft. They include timbering and hoisting from the 1900 to the 1600, but tramming on the 1600 is charged to stope filling. In view of the size of the shaft and the extremely hard rock in which it is sunk they can only be regarded as favorable.

Several records have been kept of the progress in drilling with these machines. All measurements were taken during the regular progress of shaft-sinking and with one man doing all of the work in connection with his machine; in other words no attempt was being made to establish a record. Measurements taken in a very hard rib of grano-diorite in the south end of the shaft showed a drilling speed of from 1.09 to 2.13 in. per min. on holes from 2½ to 5 ft. in depth and at all angles from flat to nearly vertical; an average for four holes was 1.64 in. per min. Allowing 32 holes to a round, which is to break 4½ ft., it will be seen that with four machines there is ample time for shooting the center cut, mucking out, drilling the side rounds and shallow cut-holes. In this connection it should be borne in mind that the actual percentage of drilling time is greater with a machine of this type than with a heavier machine.

Of course it is understood that the efficiency of the jackhamer is not due to superior drilling speed but to the ease with which it is handled. Careful records made at the Buckeye-Belmont mine at Tonopah showed that the actual drilling time in sinking the shaft with piston machines was only 160 min. per 8-hr. shift. The men wasted no time but they spent two-thirds of the shift in getting ready to drill and then in getting ready to shoot. A certain percentage of this loss, such as connecting ventilating pipe, changing steel, loading, etc., will be practically constant under any conditions. But it will be found that the greater portion of the loss is chargeable to setting up, tearing down and shifting the machine from one set-up to another. All of this loss is avoided with the jackhamer, which weighs only 40 lb.; and when the shift is ready to shoot, each man simply takes his machine into the bucket with him and the whole lot is hoisted away.

At the Black Oak shaft, ventilation is accomplished by an 8-in. Sturtevant fan on the 1600 level and compressed air at 85 to 95 lb. by an Ingersoll-Rand two-stage compressor, 11x9-16 in., belted to a 150-hp. motor. Considerable water is found in the upper levels but the shaft is dry.

The Black Oak has also used the jackhamers to some extent for drifting. They were mounted on the shell of an old machine on a vertical bar. Two of them, with one man to each, made better progress with less air than two men with one 3-in. piston machine. Detailed records of these trials were not kept.

DELAY ACTION EXPLODERS.

In connection with this shaft it is well to mention the use of delay-action exploders, to which the management is inclined to give much credit for the progress made, inasmuch as they have facilitated the firing of the shots. The "Ideal" delay-action exploder consists of a detonator, a time-fuse—whose length is chosen to suit the position of the hole—and an electric fuse-spitter to which is connected two copper wires. The detonator is placed in the cartridge in the usual manner and the copper wires attached to the fuses are connected in series, each end of the series being run to a wooden plug in a shallow hole at one end of the shaft. At these plugs connections are made with the two ends of an electriclight line brought down the shaft for this purpose. The exploder switch is in a locked box on the 1600 level, the key to the box being in the possession of the shaft foreman. There are no openings in the box for the wires leading

(*Concluded on Page 7803*).

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CONTENTS

THE U. S. NAVAL CONSULTING BOARD

The U. S. Naval Consulting Board created by Secretary Daniels, eleven national engineering societies sharing with him the responsibility for its personnel, has wasted no time in getting ready for active work. Mr. Thomas A. Edison was appointed chairman of the board by Secretary Daniels, the other members, with the societies by which they were designated, are as follows:

American Institute of Electrical Engineers—
Frank Julian Sprague and Benjamin G. Lamme.
American Institute of Mining Engineers—
William L. Saunders and Benjamin B. Thayer.
American Society of Mechanical Engineers—
William LeRoy Emmet and Spencer Miller.
American Society of Civil Engineers—
Andrew M. Hunt and Alfred Craven.
American Chemical Society—
W. R. Whitney and L. H. Baekeland.
American Electrochemical Society—
Joseph W. Richards and Lawrence Addicks.
Inventors' Guild—
Peter Cooper Hewitt and Thomas Robins.
American Society of Aeronautic Engineers—
Henry A. W. Wood and Elmer A. Sperry.
American Society of Automobile Engineers—
Howard F. Coffin and Andrew L. Riker.
American Aeronautical Society—
Mathew B. Sellers and Hudson Maxim.
American Mathematical Society—
Robert S. Woodward and Arthur G. Webster.

These men stand so high in their several professions that they accept no remuneration for serving their country in this capacity.

The first meeting of the board was held in Washington, October 6 and 7, and the following officers were elected:

Chairman—Thomas A. Edison.
First Vice-Chairman—Peter Cooper Hewitt.
Second Vice-Chairman—W. L. Saunders.
Secretary—Thomas Robins.

Mr. Saunders was the chairman at the sessions of the Board which were attended by members of the Board only, with the single addition of Mr. M. R. Hutchinson, who was present as Mr. Edison's "ear" and private assistant.

The first action of the board was to change the name from Naval Advisory Board to Na-

val Consulting Board, the change of title carrying with it the assurance that the members individually and collectively do not intend to force their advice unasked upon the Naval Board proper, but that they stand ready to place all their knowledge at the disposal of the Navy in consultation.

On October 6 President Wilson, at the White House, addressed the board as follows:

"There is very little that I can say to you, except to give you a very cordial welcome and to express my very great pleasure in this association of laymen with the Government. But I do want to say this:

"I think the whole nation is convinced that we ought to be prepared, not for war, but for defense, and very adequately prepared, and that the prepartion for defense is not merely a technical matter, that it is not a matter that the Army and Navy alone can take care of, but a matter in which we must have the cooperation of the best brains and knowledge of the country, outside the official service of the Government, as well as inside.

"For my part, I feel that it is only in the spirit of a true democracy that we get together to lend such voluntary aid, the sort of aid that comes from interest, from a knowledge of the varied circumstances that are involved in handling a nation.

"I want you to feel, those of you who are coming to the assistance of the professional officers of the Government, that we have a very serious purpose, that we have not asked you to associate yourself with us except for a very definite and practical purpose—to get you to give us your best independent thought as to how we ought to make ready for any duty that may fall upon the nation.

"I do not have to expound it to you; you know as well as I do the spirit of America. The spirit of America is one of peace, but one of independence. It is a spirit that is profoundly concerned with peace, because it can express itself best only in peace. It is the spirit of peace and good-will and of human freedom; but it is also the spirit of a nation that is self-conscious, that knows and loves its mission in the world and that knows that it must command the respect of the world.

"So it seems to me that we are not working as those who would change anything of America, but only as those who would safeguard everything in America. I know that you will enter into conference with the officers of the Navy in that spirit and with that feeling, and it makes me proud, gentlemen, that the busy men of America—the men who stand at the front of their professions—should be willing in this way to associate themselves voluntarily with the Government in the task in which it needs all sorts of expert and serious advice.

"Nothing ought to be done in this by any single group of persons; everything ought to be done by all of us, united together, and I welcome this association in the most serious and grateful spirit."

The first official recommendation of the board is for the creation of a Naval Research Laboratory, involving a first investment of $5,000,000, with annual operating expenses from $2,500,000 to $3,000,000, which means that the laboratory should be commensurate with the U. S. Navy of the future.

The Central Labor Union of Hudson County, N. J., is taking action upon the following resolution: "It is entirely consistent with trade unionism that the bodies of men who were loyal to the cause of union labor should be handled by none but union men." This is interpreted to mean that union men when they die will be laid out by union embalmers in union caskets, carried by union pallbearers to a hearse with union horses driven by a union driver, and buried in a grave dug by union grave-diggers or else cremeated by union cremators, and the obituary notice will bear the union label. Then the work of the union worms will begin.

Gas burners have been successfully used in recent experiments for the autogenic cutting of metal under water. According to the *Zeitschrift für Sauerstoff-und Stickstoffindustrie* the process is very simple. It is only necessary to screw over the point of the burner a bell-shaped hood into which compressed air is led during the cutting. The water is thus forced away from the mouth of the burner, so that the flame can burn freely. It is said that successful experiments with this new burner have been conducted at Kiel. Among others, a diver working at a depth of 5 meters cut through a square piece of iron with an edge 60 millimeters long in 30 seconds.

(*Concluded from Page 7800*).

down the shaft, so the door must be unlocked and opened before the wires are connected to their binding posts, and likewise they must be disconnected before the door can be closed. As a further precaution the switch is so arranged that the door cannot be closed unless the switch is open.

Thus the shaft men, after loading their holes and making the connections to the light line through the plugs, may leave the shaft leisurely. When the 1600 level is reached the shaft foreman goes to the switch box, opens it, connects the light-line wires to their binding posts and fires the round by closing the switch. Before he can close the door he must open the switch and disconnect the wires. Missed holes by this method are extremely rare; and it is certainly an improvement over spitting a round of holes with a candle or acetylene lamp, with the smoke so thick that one can hardly see, and then scrambling hurriedly into the bucket or up the ladder to reach a point of safety.

SCIENTIFIC HUMIDIFICATION

BY J. I. LYLE.*

So far as I am aware no mine has yet been humidified on a scientific basis or in fact in any manner that has been successful. Of those installations regarding which I have accurate knowledge, a few fundamental laws necessary for success have been neglected.

The temperature of a mine is fairly constant, varying with the seasons, so that in winter it is a few degrees cooler than in summer, with but slight fluctuations from day to day or even from week to week.

Generally a mine has sufficient humidity during the summer months, because its temperature is much below that of the outside atmosphere. In winter, however, when the outside air carries but little water vapor and the mine temperature is much higher, the relative humidity is necessarily low.

In order that the air used for ventilation may be able to carry sufficient water vapor to humidify the mine, it must be heated, either by its contact with the mine walls or artificially. The temperature to which it is heated must be at least that of the dew point desired.

Take a mine, for instance, with a temperature of, say, 60° F., where a humidity of 80 per cent. is desired with the outside air at 20° F. and containing 1 grain of vapor per cu. ft. Air at 60° F. and saturated carries 5.75 grains per cu. ft. With 80 per cent. humidity, therefore, each cubic foot would have to contain 80 per cent. of 5.75, or 4.6 grains. Now saturated air at 50° F. will just hold 4.6 grains per cu. ft. It is evident from this that it is necessary that the air should not be less than 54° F. when the additional water vapor is added. If at any lower temperature it could not possibly hold the required amount of vapor to give the 80 per cent. humidity.

It must be borne in mind that water cannot be evaporated unless heat is added; or to state it in another way, if water is caused to evaporate in the presence of air without heat being applied, the air will be cooled 8° F. for every grain of water evaporated per cubic foot.

This being true, if the air entering the mine at zero is raised to a temperature of 54°, the only way the necessary moisture can be added would be by blowing steam directly into it. It is well known that the introduction of steam directly into the air current without the production of fog is a most difficult matter, if it may ever be said to be successfully accomplished.

With the case under discussion, with the incoming air containing 1 grain of vapor per cu.ft. it would be necessary to add 3.6 grains per cu.ft., which if done without adding heat, as explained, would cool the air to approximately 28° F. To counteract this cooling effect we could heat the air to 82° F. and then bring it in contact with atomized water sprays and add the 3.6 grains per cu.ft., and as a result of the evaporation it would be cooled to 54°. At this temperature of 54° the air would be saturated, but as it traveled through the mine and its temperature was raised to 60° the humidity would be lowered to 80 per cent. such a system properly installed would give good results without any fog or other objectionable results. A simpler and more practical method is to first pass the air used for ventilating the mine through a humidifier, where its temperature is raised and the necessary amount of moisture is added simultaneously. Such a machine is now being adopted in textile mills for cooling and humidifying the air.

*Treasurer, Carrier Engineering Corp., 39 Cortlandt, street, New York City.

Here the air passes through a dense and finely divided water spray, where it is saturated. The water used is circulated by means of a centrifugal pump and is heated by the introduction of exhaust steam. Eliminator plates at the outlets are used to separate the surplus water from the air, so that the air is left perfectly free of any fog or other small particles of water that have not been evaporated. Because of the recirculation of the spray water employed by this machine, the amount of water required is small and is equal to that evaporated. This would never exceed 1 gal. for each 12,000 cu.ft. of air used.

The exhaust steam required to heat the spray water (which in turn would heat the air to 54° F.) would be 1½ lb. per 1000 cu.ft. of air handled. Of course, with a large ventilating fan this amounts to considerable steam, but in most mines there is sufficient exhaust going to waste to fulfill the requirements.

To summarize: First, it is necssary that the moisture for mine humidification be injected into the air after its temperature has been raised to approximately that of the mine. secondly, this moisture must be added in such a manner as not to cool the air below the temperature required to carry the desired vapor. Thirdly, the injection of steam into the air at or near the entrance of the mine is sure to produce fog and cannot add the amount of vapor required owing to the temperature of the air being too low to carry it. Eourthly, the humidity of a mine can be maintained uniformly at a desired point by a properly designed humidifier, with heated spray water, located at the air entrance to the mine. *Coal Age.*

CO-OPERATION AND INTERDEPENDENCE OF THE CIVIL AND MECHANICAL ENGINEER

BY GEO. W. DICKIE.

[The following is an extract from an address by Mr. Dickie as Vice-President of the American Society of Mechanical Engineers in response to an address of welcome to the Society by Mr. C. C. Moore, President of the San Francisco Exposition.]

It is very fitting, sir, that you should bid us welcome at this time, as we are here like many others to help celebrate the greatest engineering achievemnt of our time, the cutting in two of the Western Hemisphere, joining the two great oceans of the world, forming a new pathway for the world's commerce. Our great Exposition that celebrates the completion of this great work, has developed into a thing of wondrous beauty, with you, sir, as its guiding head. It is true, that another engineering society will naturally claim first honors in the great work that we celebrate, yet it must never be forgotten that the civil engineer can not go very far in any work he undertakes without the active help of the mechanical engineer. If he wants to dig either a big or a little ditch, and needs a shovel for the purpose, either an ordinary 25 lb. hand shovel or a fifteen ton steam shovel, he must get the mechanical engineer with him before he can do any digging, and at this time it is worth while remembering that nearly all the great work carried out under the civil engineer is necessary, because of what the mechanical engineer has been doing. The great steamships that originate with the mechanical engineer, made the Panama Canal a necessity. The locomotive engine, with its long line of cars, makes necessary the tunnels and bridges that the civil engineer constructs for their passage. In fact, nearly all great modern works of which the civil engineer is so justly proud, have been produced in order that the work of the mechanical engineer may either run over or through them. The work of the civil engineer is more spectacular and more in the public eye, thus exciting admiration that is reflected on the designer and builder.

Sailing on one of the Hudson River day steamers, up that splendid river about two years ago, I saw ahead an airy structure spanning the river at a great height, looking like a huge spider web, too attenuated in appearance to serve any practical purpose, but as the boat came nearer, the stability of this structure became more apparent, and admiration of the boldness of it began to take possession of my mind, then something appeared at one end of this airy structure, and quickly took possession of it as a pathway to the other side. Here was the explanation of it all. The mechanical engineer needed the Poughkeepsie Bridge for his locomotive and train to cross the river, and he also needed the river for his steamer, and so we find as we contemplate the work of these great

branches of engineering, that they are "Useless each without the other." The one is static, that is engineering in repose, the other dynamic—engineering in motion, and they are every day becoming more important factors in the work of the world. Even war has now become largely a job for the mechanical engineer, and seeing that we can neither live comfortably, nor die bravely without the help of the mechanical engineer, his position among the useful elements of society should be improved, so that he would occupy a place in the estimation of his fellow men commensurate with the indispensable character of the service he renders to the world. I would not seek a higher place for the mechanical engineer than that which is freely granted the civil engineer, but it should not be lower, and it is one of the functions of the Society that I represent here to-day, to help the mechanical engineer find his true place among the professional men of his time.

To the 6,000 members of this Society, the country is largely indebted for the position she occupies among the nations of the earth. That she is able to furnish other nations with so many implements through which progress is made, is largely due to the work accomplished by members of this Society. That the reward that comes to them financially is not what it ought to be is shown by the small percentage of our members who have been able to cross the continent, and see the wonderful dream that has become a fact, sir, under your direction—and attend the meetings to be held here. This is to be regretted, but cannot be helped. Engineers as a rule do not acquire wealth, and perhaps it is just as well for them that they don't—there would be less good work done if it were better paid for. The best work that has ever been done for this old, ungrateful world of ours, was never paid for. You can't do the things that you think ought to be done, if you wait for a contract insuring pay before you do them. Many noble engineers still do the things they love to do without any thought of pay, and so long as that is the case, we can well be proud of our profession. The present President of this Society is a splendid example of the character of man I refer to. It has often been said of the family I belong to, that they would rather build ships and starve, than do anything else and become rich, and I trust they will continue in that frame of mind.

DEOLEIZER

This is a word which has not yet found its place in the dictionary. It represents an apparatus for removing oil from condensed steam or from any water in which oil is emulsified. It is in a class by itself entirely removed from the so-called oil separators. It takes out all the oil (which no mechanical straining or filtering can do) so that the water will even be drinkable or, without any other treatment, can be used directly for the manufacture of ice.

Advantage is taken of the phenomenal affinity for oil of a novel composite material, which has been named oleite. This is not an invention but a discovery. It is of a mineral character and resembles granulated charcoal or old-fashioned black gunpowder, but is very different from either. A mass of this material is suspended in a wire basket within the deoleizer and the pipes are constructed so that the water will flow through. An ordinary filter charged with, say, sand, charcoal or bone-black, is dependent for its capacity and efficiency almost entirely upon its surface area, which is not the case with oleite. The voids are large in it, the oily water penetrates all through the mass, and the deposition of oil is substantially as effective within the body of the material as on the surface. When the oleite is approximately saturated or clogged with oil it can be renewed over and over again by dumping into a steel tray and heating to redness over a furnace fire, this merely burning out all the oil.

The deoleizer is being installed entirely upon specific guarantees of performance, and it already has a great record of savings, especially in connection with the boiler feeds of large plants. A very convincing circular and full information on the deoleizer is supplied by Williams Andrews, Inc., 120 Liberty St., N. Y. City.

NOTES

Uniformity of burning speed is a desirable quality, but fuse that burns in the open air with a maximum variation of 10 per cent. up or down from standard, is within reasonable limits. The generally accepted speed is 90

seconds per yard, or 25 minutes per 50 ft. This is fast enough to preserve a fair degree of regularity, and slow enough to produce quiet burning.

Heat increases the speed of hardening concrete. Setting by steam has been successfully employed in constructing the 27-mile concrete pipe line from Sooke Harbor to Vancouver B. C. The pipe is constructed in sections, each section being immersed in live steam for 24 hours, the steam causing the concrete to set as well as would otherwise be obtained by a month's exposure to the air at ordinary temperatures.

The Minnesota ranges are still producing more iron ore than is produced in the rest of the States together, having furnished 52.96 per cent of the total for the United States in 1914, as compared with 62.37 per cent in 1913. The Lake Superior district, comprising all the mines in Minnesota and Michigan and those in northern Wisconsin, mined 33,540,403 tons in 1914, or 80.94 per cent of the total production.

Attention is called to the fact that when using the oxy-actylene flame for welding the temperature is so great as to cause the vaporization of some metals; and as the operator has to hold his head quite close to the work he must necessarily inhale some of these metallic fumes, with possible injury to his health. It is suggested that, as the operator must wear colored goggles in any case to protect his eyes from the intense light, it might be well to combine these in a helmet that would protect his lungs.

Anyone can understand the application of good sense, good will and system in mills and factories, but no American can approve any plan that lessens the responsibility of the individual by turning him into a machine. That is not real progress, even though it may enable some shop to get out a few more bolts at a reduced price. The word "efficiency" has thus been overworked. It bids fair to become so offensive as to drive us into a reaction against all activity that concerns itself with materials, unless the soul goes with it. —*Ira N. Hollis.*

Many American railroads are obliged to use heavy envelopes of large size for transmitting papers from one department to another, and this entails considerable expense. As it is not usually necessary to seal these envelopes, and they are, therefore, not subject to mutilation, it has been found possible to use these envelopes a number of times; and to facilitate the process, and to insure the economy, lines are printed on the face of the envelope for a dozen addresses, each being crossed off after it has served its purpose.

A "smoke tintometer" has been devised to be used in determining at any time or place the degree of smokiness of the atmosphere. It consists of a tube with a single eye-piece and two object openings. One of these openings is clear while in front of the other is a rotatable diaphragm in which are set five discs of glass, one clear and the others with various tints corresponding with the standard tints of a "smoke-chart." In judging smoky air the diaphragm is turned until the tinted glass approximately coincides in darkness with the air seen through the clear aperture.

As soon as the war comes to a close on the other side of the water there is going to be a shortage of cutters and carvers in this country. It is time for the wise business men to provide the labor saving equipment of pneumatic tools and every other labor saving device, so as to be in a position to maintan the business short handed, for such a condition is sure to arise.—*American Stone Trade.*

Citizens of the new town of Anchorage, the Cook's inlet headquarters for the Alaska Engineering Commission, have begun preparations to create a model village, following the completion of the government's first sale of town lots. Out of 1,178 lots offered, 635 were sold for a total of $147,235. Anchorage is to be made a model town in every respect. J. A. Moore, manager of the town, for the government, is mayor. He has issued strict rules regarding building and sanitation.

Charles A. Fritz, who during the summer and fall of 1914 was engineer in charge of the construction of a sewer outfall at Manchester, Mass., describes the using on the work of a

pneumatic hammer under water. The outfall extended two miles into tidal waters ranging in depth below mean low water from zero to 40 ft. At a depth of about 16 ft. two small ledges were encountered in the trench. The contractor (the T. A. Scott Co., New London, Conn.) had a timber crib, which was to be used to support a steam drill on a tripod. Mr. Fritz suggested the use of a "Jackhamer" pnuematic-hammer drill, which was successfully tried. The only drawback to this use of the drill was that the exhaust annoyed the divers, but this was easily remedied by bringing the exhaust to the surface by the use of a common garden hose.

Quebec, Aug. 20.—While two young boys named Pichette, brothers, aged 14 and 8, were playing in the C. P. R. shops this evening the elder placed an air compressor hose against the younger's body and called to an engineer who was playing with them in the next room to turn on the air. Ignorant of what was going on the engineer did so, the result being that the boy's body was blown open, and he died a short time afterwards.

[It is of course understood that in this case, as in some similar horrible cases which are matters of record, the air nozzle was not placed *against* the boy's body.—Ed. C. A. M.]

A weather Bureau Station has just been established on a farm near Omaho, Neb., for the purpose of making systematic observations of the upper air, by means of kites carrying self-recording instruments. It was not necessary to erect new buildings, excepting a small shelter for the kite reel, as the buildings on the farm were sufficient for the needs of the work. This work was formerly carried on at Mount Weather, Va., and the apparatus was moved from that station to the present one. This station will be known as the Drexel Aërological Station, and the observations obtained here will be sent to the Central Office of the Weather Bureau at Washington, D. C., for computation and study. Kite flights were begun at this station Sept. 1.

Sulphur and yellow fever are not usually thought of together, but it was the employment of 300 tons of sulphur and 120 tons of insect powder, the entire supply of the United States, that enabled Gen. Gorgas to destroy the mosquitos in Panama and so thoroughly eradicate yellow fever that no case has occurred since May, 1906. Before the use of sulphur and other sanitary measures the annual death-rate from yellow fever expected, on the basis of the French ratio, was 3,500. The death-rate during the French occupation was 200 per 1,000. In ten years of the American control the rate was 17 per thousand.

Probably more copper has been destroyed, as we say it, or has gone beyond human pen, in this one year of war than was previously destroyed in all of the world's history. Copper as used for the manufacture of ordinary articles is not destroyed and is ultimately available for other uses, but copper used in ammunition is absolutely lost.

Nickel has become one of the precious metals in Europe. It is said that the Germans have been gathering all the nickel coins available in Belgium and in Germany for use in the manufacture of war materials. As a result, the Federal Council of the German empire is reported to have passed a bill to coin 5 pfennig pieces in zinc instead of in nickel as heretofore.

The Weather Bureau has undertaken a campaign for the determination of the relative values of evaporation in various parts of the United States, and, if possible, the relation of these values to other climatic factors. The Bureau is also preparing to publish the results of its previous elaborate observations of evaporation at Salton Sea and elsewhere.

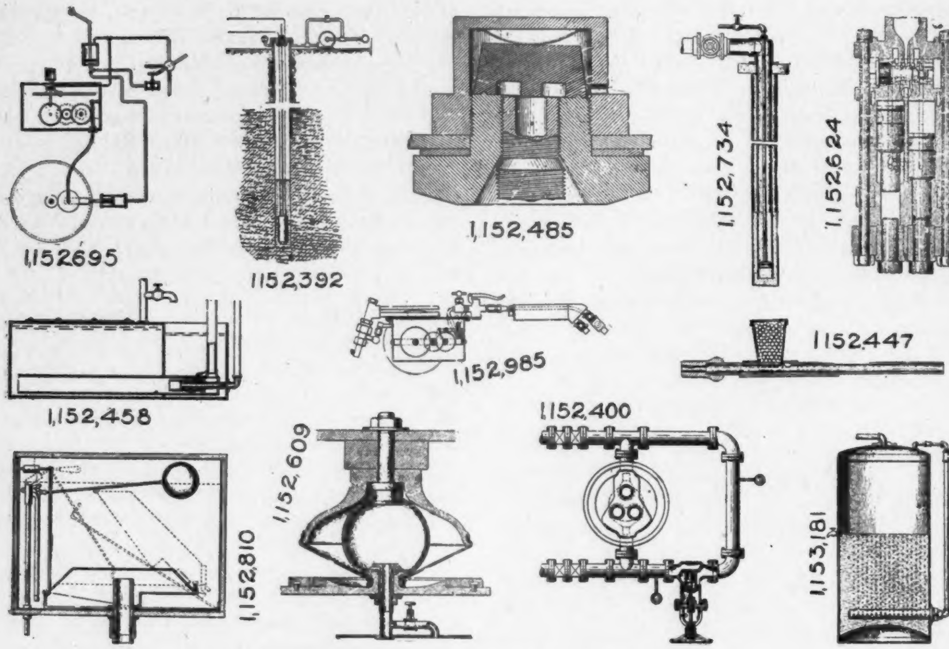
LATEST U. S. PATENTS

Full specifications and drawings of any patent may be obtained by sending five cents (not stamps) to the Commissioner of Patents, Washington, D. C.

SEPTEMBER 7.

1,152,392. METHOD OF TREATING SUBTERRANEAN WELLS. EDWARD NICKLAS BREITUNG, Marquette, Mich., and ALFRED PICK, New York, N. Y.

2. The method of treating subterranean wells which consists of heating the material in the well, applying a continued artificial pressure to the material greater than the natural pressure thereon for a substantial period of time to thereby force said heated material into the openings of the



PNEUMATIC PATENTS SEPTEMBER 7.

surrounding medium and in then releasing the artificial pressure to allow the material to again enter the well.

1,152,400. MEANS FOR CONTROLLING THE OPERATION OF AIR AND GAS COMPRESSORS. JAMES H. DENNEDY, Detroit, Mich.

1,152,414. WET DUST-COLLECTOR. GEORGE A. HELSON, Peterborough, Ontario, Canada.

1. In a dust collector the combination of a blower provided with a suction inlet; means for introducing water into the blower; a discharge pipe for the blower; a water tank into which the discharge pipe leads; and baffles in said discharge pipe close to the blower and inclined alternately in opposite directions whereby the water is beaten into fine spray and intimately mixed with the dust-laden air passing through the apparatus.

1,152,447. AIR-GUN. WILLIAM J. SPROULL, Saginaw, Mich.

1,152,449. AIR CAN-TESTING MACHINE. EDWIN V. SWANGREN and MAGNUS E. WIDELL, Maywood, Ill.

1,152,458. APPARATUS FOR BLEACHING CANE-JUICE. WILLIAM H. WAGGONER, Jeanerette, La.

1,152,473. VACUUM-CREATOR. EDWARD M. BARNES, Hastings, Mich.

1,152,485. DISCHARGE CONTROL FOR FLUID-RECEPTACLES. JOHN E. CARROLL and WILLIAM H. ANDREWS, Boston, Mass.

1,152,609. PNEUMATIC SPRING. BENJAMIN WALTER DAVIS, Phillips, Wis.

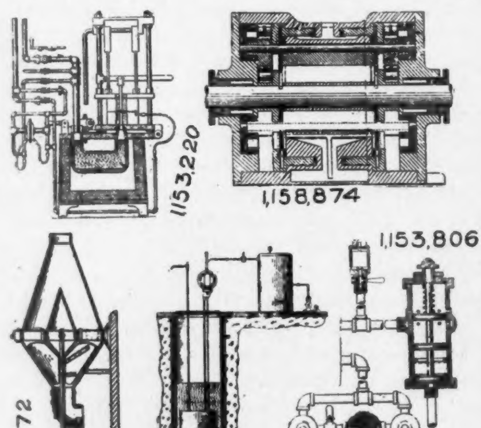
1. A pneumatic spring comprising a substantially globular fluid retaining chamber having flexible walls, curved means engaging the flexible walls of the retaining chamber to increase the supporting area thereof at a predetermined rate when weight is applied thereto, and means for connecting said chamber to two relatively movable members between which the chamber is interposed.

1,152,624. PNEUMATIC TOOL. GEORGE H. GILMAN, Claremont, N. H.

1,152,695. BRAKE-ACTUATING DEVICE FOR AUTOMATIC TRAIN-STOP MECHANISM. FRED BEDFORD, Stratton, Nebr.

1,152,734. PUMP. JOSEPH F. JONES, JR., Bakersfield, Cal.

In a compressed air lift pump, the combination with an outer circular flow pipe, of an air pipe concentrically positioned therein and extending to a point adjacent the lower end thereof to provide an annular space between said flow pipe and said air pipe, a T-shaped casing secured on the lower end of said air pipe and having its opposite



PNEUMATIC PATENTS SEPTEMBER 14.

ends closed, a discharge nozzle projecting at substantially right angles from said casing on diametrically opposite sides of said air pipe substantially midway of said annular space, said nozzle being inclined to the vertical and discharging upwardly to produce a spiral motion around said air pipe, the construction and arrangement of parts being such that air bubbles move inwardly toward the air pipe and decrease the friction between the surface thereof and the body of ascending water.

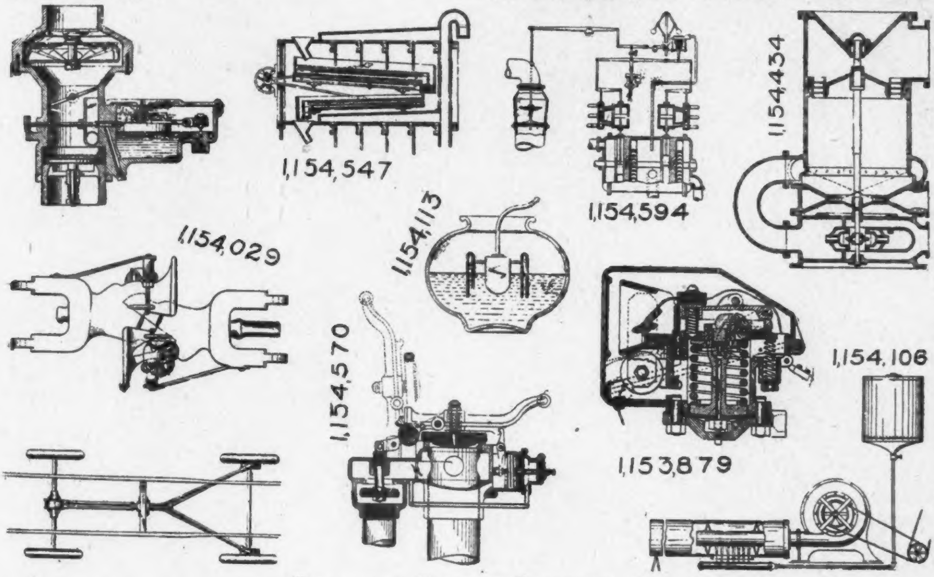
1,152,810-1. PNEUMATIC VALVE APPARATUS. GEORGE A. HANLY, Elgin, Ill.

1,152,882. DEVICE FOR ROTATING PNEUMATIC DRILLS. HENRY J. COOK, Los Angeles, Cal., and HERBERT E. MARSDEN, Ottumwa, Iowa.

1,152,985. ACETYLENE-BLOWPIPE. JOHN W. SMITH and ELMER H. SMITH, Minneapolis, Minn.

1,153,026. TIRE-PRESSURE GAGE. ROBERT A. CAMPBELL, Minneapolis, Minn.

1,153,181. AIR-DRIER. GEORGE F. STEEDMAN, St. Louis, Mo.



PNEUMATIC PATENTS SEPTEMBER 21.

SEPTEMBER 14.

1,153,198. APPARATUS FOR RAISING WATER. WILLIAM T. CROSLEN, Oklahoma, Okla.

1,153,220. CASTING-MACHINE. CHARLES M. GREY, East Orange, N. J.

1. In a casting machine, the combination of two chambers having communication below the surface of material adapted to be contained therein, means for exhausting air from both of said chambers, whereby a partial vacuum is produced above the material therein and the metal freed from entrained gases, and means whereby one of said chambers may be exhausted independently of the other.

1,153,554. PNEUMATIC PIANO-PLAYER ACTION. WALTER A. KRUCK, New York, N. Y.

1,153,734. VACUUM CLEANING APPARATUS. WALTER G. TRAUTMAN, Cleveland, Ohio.

1,153,759. FLUID - PRESSURE-CONTROLLING VALVE. JOSEPH BRUNKER and CHARLEY ALBERT MATTMILLER, Helena, Mont.

1,153,806. AIR-BRAKE DEVICE. ERNEST U. MACK, Florence, S. C.

1,153,872. VENTILATOR-FAN. DAVID W. MATSLER, Kingston, Okla.

1,153,874. ROTARY COMPRESSOR. WILLIAM SHORE, Toronto, Ontario, Canada.

SEPTEMBER 21.

1,153,879. PNEUMATIC GOVERNOR. BURTON S. AIKMAN, Chicago, Ill.

1,153,913-4-5. MIXING DEVICE. FORREST A. HEATH, Jersey City, N. J.

1,153,930. FLUID-POWER TRANSMISSION. ARCHIBALD T. KEENE, Chicago, Ill.

1,154,028. TRAIN-PIPE COUPLING. HOWARD S. KIMMEL, Tiffin, Ohio.

1,154,029. FLUID-PRESSURE COUPLING-HEAD. HOWARD S. KIMMEL, Tiffin, Ohio.

1,154,106. AIR-BLAST-HEATING APPARATUS. FERDINAND EPHRAIM, San Francisco, Cal.

1,154,113. HUMIDIFIER. WILLIAM S. HADAWAY, Jr., New Rochelle, N. Y.

1,154,306. VACUUM-INDICATOR. GEORGE F. GRAY, Schenectady, N. Y.

1,154,434. ROTARY CONDENSER AND SELF-CONDENSING TURBINE. EDMUND SCOTT GUSTAVE REES, Stafford, England.

1. An ejector condenser, air pump or compressor, comprising an entraining chamber connected with the space to be evacuated, an ejector wheel, spraying nozzles connected with a supply of liquid under pressure and adapted to direct sprayed liquid across the entraining chamber into the rim of the ejector wheel, and a stationary expanding duct to which the ejector wheel delivers.

1,154,547. PROCESS OF PURIFYING FLOUR DURING THE MANUFACTURE THEREOF. GEORGE THOMAS SMITH, Fort Worth, Tex.

1. The herein-described process of purifying flour containing impurities lighter in weight than flour, which consists in moving said flour and impurities in a relatively thin layer and simultaneously forcing a slight draft of air uniformly throughout said moving layer for lifting and carrying away said lighter impurities from said flour.

1,154,570. PNEUMATIC - DESPATCH - TUBE APPARATUS. CHARLES P. HIDDEN, Winchester, Mass.

1,154,594. REGULATING DEVICE FOR MIXED-PRESSURE TURBO - COMPRESSORS. RICHARD H. RICE, Lynn, Mass.

SEPTEMBER 28.

1,154,609. METHOD OF INCREASING THE ENERGY OF A FLUID-MOTOR IN MOTOR-DRIVEN TORPEDOES. MICHEL BRUNIQUEL, Paris, France.

1. The process of increasing the energy supplied to a motor driven by compressed fluid which consists in subjecting such fluid while on its way to the motor, to the heat of a suitable fuel in combustion while injecting hydrogen peroxid into the sphere of combustion.

1,154,648. FLUID-PRESSURE TURBINE. CARL J. MELLIN, Schenectady, N. Y.

1,154,672. WHISTLE. RICHARD TIKIJIAN, Waterbury, Conn.

1,154,707. SPRAYING DEVICE AND MEANS FOR CONTROLLING THE SAME. DANIEL M. LUEHRS, Toledo, Ohio.

1,154,745. METHOD OF AND APPARATUS FOR ELEVATING FLUIDS BY ELASTIC-FLUID PRESSURE. RALPH C. BROWNE, Salem, Mass.

1. The method of raising fluids by elastic fluid pressure to a height greater than that of a continuous column of the fluid operated on sufficiently high to balance such pressure, which consists in flowing a working fluid through a loop, simultaneously causing the heavier fluid to collect in said loop until the passage there through for the working fluid is closed, and immediately displacing the collected fluid by pressure of the working fluid applied downwardly on the upper surface thereof, thereby forming a composite column made up of alternate masses of the fluid operated on and the lighter working fluid.

1,154,793-4-5-6. COMPRESSED-AIR SYSTEM FOR OPERATING PNEUMATIC TOOLS. CHARLES OTIS PALMER, Cleveland, Ohio.

1,154,797. PNEUMATIC TOOL. CHARLES OTIS PALMER, Cleveland, Ohio.

1,154,798. GOVERNOR FOR AIR-COMPRESSORS. CHARLES OTIS PALMER, Cleveland, Ohio.

1,154,880. POWER-GENERATING SYSTEM. JOHN PATTEN, Baltimore, Md.

1. The method of employing carbon dioxid, as a medium for converting heat into work, which consists in successively compressing the carbon dioxid, heating it, expanding it in an engine, and cooling it, and wherein the lowest pressure during these operations is not substantially less than critical pressure.

1,154,894-5. GLASS-FORMING MACHINE. WILLIAM S. TEEPLE, Wellsburg, W. Va.

1,154,921. PERCUSSIVE DRILL. CHARLES C. HANSEN, Easton, Pa.

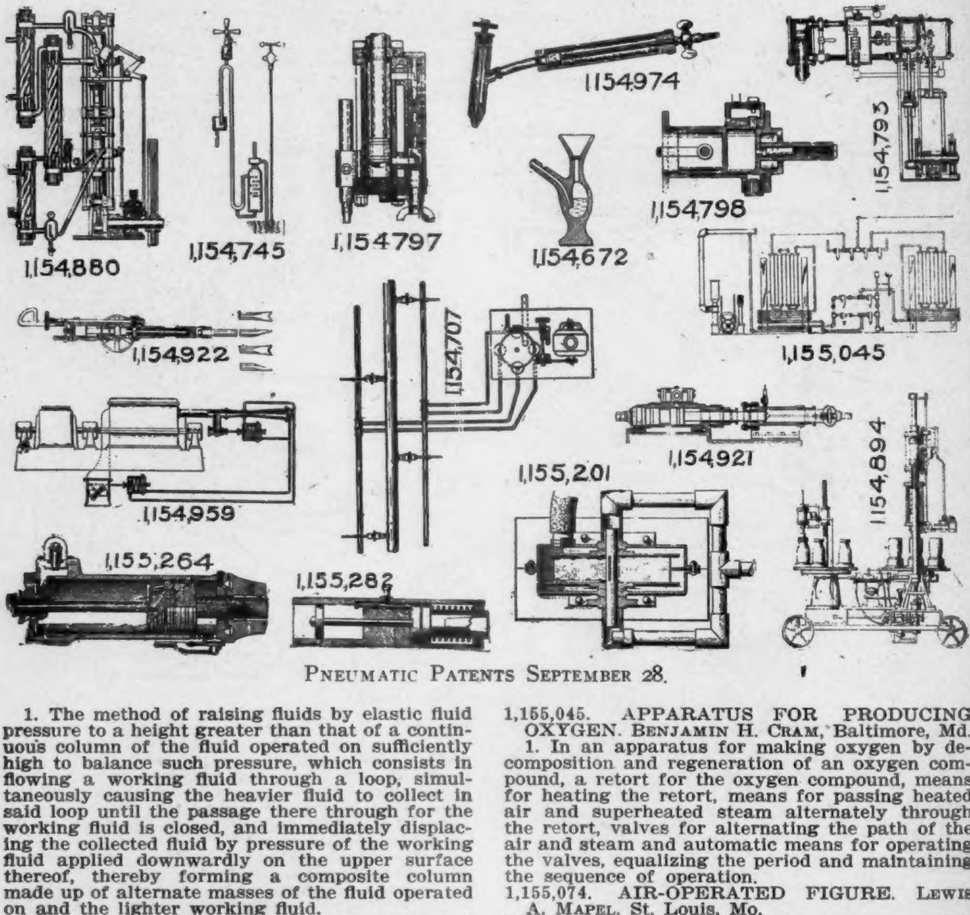
1,154,922. COAL-MINING MACHINE. CHARLES C. HANSEN, Easton, Pa.

1,154,957. PNEUMATIC MUSICAL INSTRUMENT. HARRY J. ANDERSON, Chicago, Ill.

1,154,959. REGULATING MEANS FOR CENTRIFUGAL COMPRESSORS. OTTO BANNER, Easton, Pa.

1,154,974. WELDING-TORCH. BURR CUSTER, Marion, Ind.

1,154,977. PULSATORY TOOL. CLARENCE A. DAWLEY, Plainfield, N. J.



PNEUMATIC PATENTS SEPTEMBER 28.

1,155,045. APPARATUS FOR PRODUCING OXYGEN. BENJAMIN H. CRAM, Baltimore, Md.

1. In an apparatus for making oxygen by decomposition and regeneration of an oxygen compound, a retort for the oxygen compound, means for heating the retort, means for passing heated air and superheated steam alternately through the retort, valves for alternating the path of the air and steam and automatic means for operating the valves, equalizing the period and maintaining the sequence of operation.

1,155,074. AIR-OPERATED FIGURE. LEWIS A. MAPEL, St. Louis, Mo.

1,155,177. FLUE-BLOWER. GEORGE H. VAN SCHAICK, Hudson Falls, and PATRICK BURNS and JOHN REARDON, Fort Edward, N. Y.

1,155,201. VACUUM-CREATOR. CHARLES H. BEST, Morland, Kans.

1,155,264. PRESSURE DEVELOPING AND DRIVEN TOOL. ALEXANDER PALMROS, Syracuse, N. Y.

1,155,272. DUST-COLLECTOR FOR PNEUMATIC STREET-SWEEPING MACHINES. JOHN R. POLLOCK, Long Beach, Cal.

1,155,282. PNEUMATIC HAMMER. MACONIUS SHANER, Bethlehem, Pa.

1,155,308. PROCESS OF CONDITIONING AIR. DANIEL P. GOSLINE, Boston, Mass.

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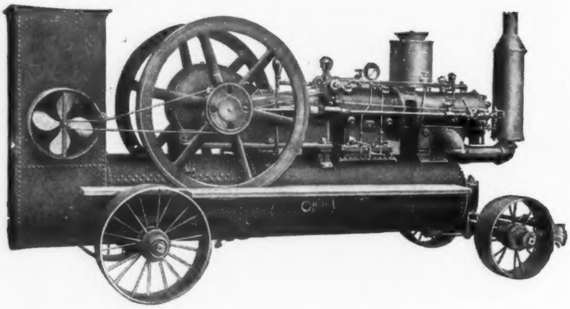

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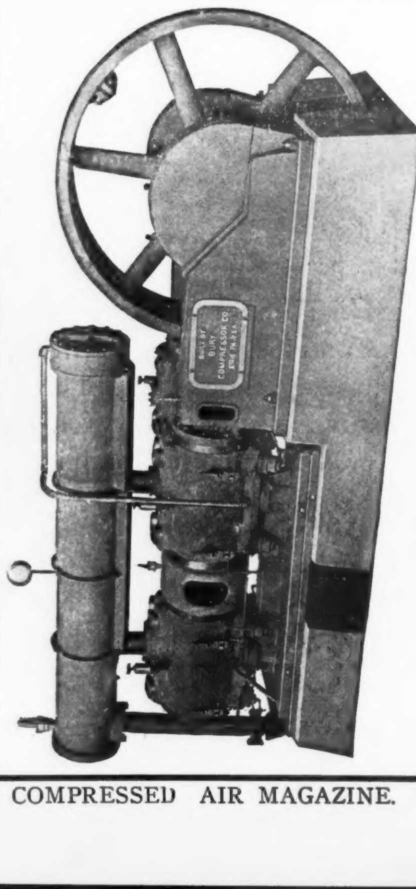

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